Base Load Power Hub (BLPH)

LOPA Allocation Report

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HAZOP Report

BLPH Project LOPA

Prepared for – Crosswind C.V.

Document Number: CRW-02-R-01

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EXECUTIVE SUMMARY

Crosswind, a Shell and Eneco joint venture, was awarded the tender to develop the offshore Hollandse Kust Noord (HKN) wind farm, located 18.5km off the coast of Netherlands near the town of Egmond aan Zee. The consortium plans to have HKN operational in 2023 with an installed capacity of 759MW generating at least 3.3TWh per year. This is sufficient renewable power to supply more than 1 million Dutch households with green electricity.

The Hazard and Operability (HAZOP) Workshop for this project took place from the 27th - 30th November 2023, followed by the Layer of Protection Analysis (LOPA) Workshop on the 1st December 2023.

The objective of the HAZOP/LOPA was to identify and assess the key Health, Safety, Security and Environmental Risks and decide on the mitigations required for bringing the risk level to As Low As Reasonably Practicable (ALARP).

Based on the analysis performed in the HAZOP workshops for equipment within the Rosetti scope of works (this excludes package items within the Rosetti scope), Five scenarios were identified that required review by LOPA. Three scenarios were identified which included a safety instrumented function, which were evaluated to determine the risk reduction factor required of the function.

Fourteen recommendations were made in addition to those made in the HAZOP which relate to demonstrating that the risks are reduced to ALARP.

ISSUE RECORD

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1.0	08-Dec-23	Thomas Fairclough	Mike Bates	Simon Jardine	First issue
2.0	12-Jan-24	Steve Forster	Mike Bates	Mike Bates	Incorporating Client comments
3.0	04-Apr-24	Steve Forster	Mike Bates	Mike Bates	Incorporating HKN comments

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Dominik Sznajder	CrossWind, The Hague, The Netherlands
File	Risktec Solutions BV, Rijswijk, The Netherlands

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ABBREVIATIONS

Abbreviation	Description	Abbreviation	Description
ALARP	As Low As Reasonably Practicable	MAH	Major Accident Hazard
BLPH	Base Load Power Hub	PEFS	Process Engineering Flow Scheme
BPCS	Basic Process Control System	PFD	Process Flow Diagram
DEP	Design and Engineering Practice	SIF	Safety Instrumented Function
DSM	Downstream Manufacturing	SIL	Safety Integrity Level
HAZOP	Hazard and Operability	TOR	Terms of Reference
HKN	Hollandse Kust Noord	VooW	Van Oord Offshore Wind
HSSE	Health Safety Security and Environment	C&E	Cause & Effects
IPL	Independent Protection Layer	LO	Locked Open
LOPA	Layers Of Protection Analysis	TOR	Terms of Reference

1 INTRODUCTION

1.1 Background

1.1.1 Project Overview

Crosswind, a Shell and Eneco joint venture, was awarded the tender to develop the offshore Hollandse Kust Noord (HKN) wind farm, located 18.5km off the coast of Netherlands near the town of Egmond aan Zee. The consortium plans to have HKN operational in 2023 with an installed capacity of 759MW generating at least 3.3TWh per year. This is sufficient renewable power to supply more than 1 million Dutch households with green electricity.

Offshore wind farms produce intermittent electricity and balancing these dips and peaks and integrating this electricity into the national energy system requires new technologies. For this reason, the offshore wind farm will include several new technologies that could be implemented at full-scale in the future. The new technologies being explored include a floating solar park, a short-duration battery storage as well as long-term storage via green hydrogen produced by water electrolysis and subsequently consumed in a fuel cell. The combination of these individual measures, herein referred to as the Base Load Power Hub (BLPH) will ensure a continuous power supply regardless of the wind situation.

1.1.2 Project Location

The Hollandse Kust Noord (HKN) wind farm is located 18.5km off the coast of the Netherlands near the town of Egmond aan Zee.

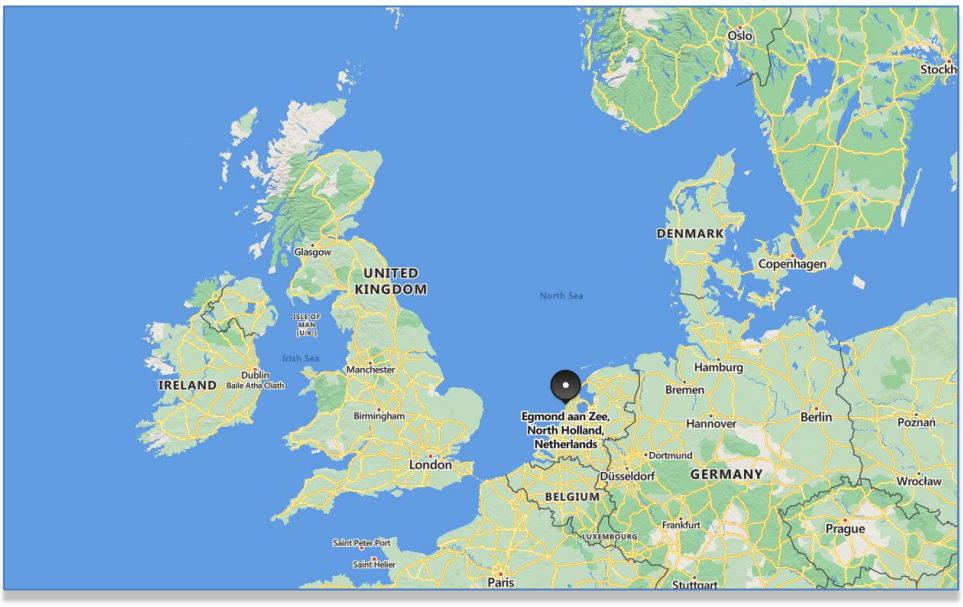


Figure 1: Hollandse Kust Noord Wind Park Location Map

The wind farm will consist of No. 69 x 11.5MW wind turbine generators each to be installed on a dedicated monopile structure. A 70th monopile located on coordinates E 590719.1, N 5841602.3 is reserved for installing the platform accommodating the BLPH. The monopile structure was designed and installed by Van Oord Offshore Wind (VooW) and therefore not part of the BLPH scope.

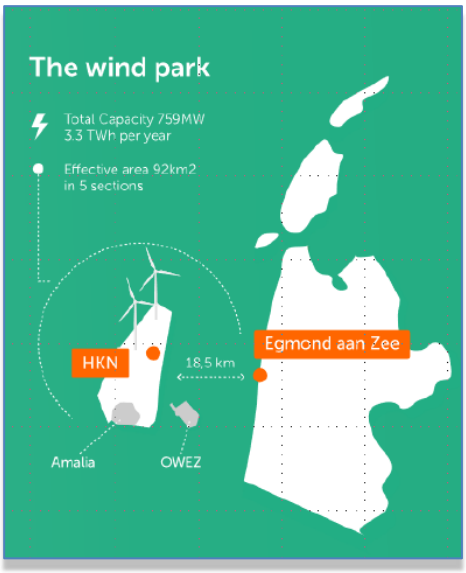


Figure 2: Wind Park Details

1.1.3 Project Concept

All components included in the BLPH will be integrated onshore on a topsides and installed in an offshore location within the boundaries of the HKN wind farm. At its simplest, the BLPH will store energy during periods of high electricity generation from renewable sources (a wind turbine generator and the floating solar PV farm) and release it during periods of low generation. In practice. It is expected that the energy stored will supplement generation from renewable sources to ensure that at least 1.0MW of power is exported to the electrical grid regardless of wind/solar availability.

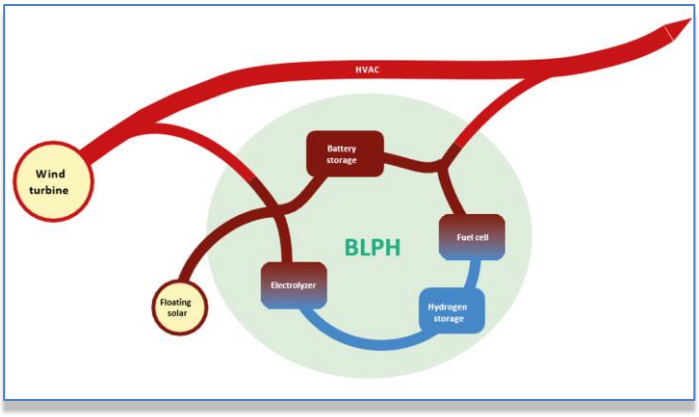


Figure 3: BLPH Concept

Electricity in the BLPH will be stored in the form of electrons in a battery energy storage system (BESS) as well as converted into green hydrogen via water electrolysis. When the power output from the connecting wind turbine drops to below 1 MWe, the BLPH will return its stored energy to supplement the remaining power output. This will be by discharging the BESS, while stored hydrogen will be converted back into electricity using a fuel cell to extend the discharge duration.

The purpose of the BLPH s to function as a testbed for the integration of energy storage technologies with renewable generation. It is expected that equipment installed on the BLPH will operate as Normally Unmanned Installation for at least two (2) years with no or minimal maintenance and it will have its own independent control room with the ability to communicate with Crosswind's control room.

1.2 Report Scope

This document is the Layer of Protection Analysis (LOPA) report for the Integration Package Scope. The Hazard and Operability Study (HAZOP) study was integrated with the LOPA, for which a separate HAZOP report has been issued [Ref 4].

1.3 Report Objectives

The objectives of this LOPA report are to:

- Define the boundaries of the LOPA study;
- Present the workshop details and composition / competencies of the workshop team;
- Define the main documents that were used during the HAZOP workshop;
- Present the findings of the LOPA workshop, including:
    - LOPA worksheet; and,
    - LOPA recommendations.

1.4 HAZOP Report

The HAZOP study was integrated with the LOPA, for which a separate HAZOP report has been issued [Ref 4].

2 LOPA METHODOLOGY

2.1 Introduction

The LOPA was carried out immediately following the conclusion of the HAZOP workshop for the Rosetti scope [Ref. 3] which covered all equipment considered to have the potential for a Major Accident Hazard (MAH), noting that the HAZOP was not fully completed (see Section 3.2).

The LOPA was carried out in full accordance with the Shell LOPA DEP.

LOPA was applied to risk assessment scenarios for the following situations:

a) To establish the Probability of Failure on Demand (PFD) target for each SIF listed as a barrier, when it has not been specified elsewhere (e.g., a DSM model bowtie or specified in a DEP);

   Note that the SIF must have had the design intent to protect against the consequence being considered to trigger a LOPA for this consequence.

   An example of a DEP specified PFD is the requirement for a SIL 2 rated backflow protection in case backflow can lead to overpressure.

b) When the HAZOP or other risk assessment team considered that there might not be sufficient barriers;

c) If required per local regulatory or by the business to support ALARP demonstration.

Where the risks were well understood, if there is a standard and good practice (industry standards, DEPs) to follow, (e.g. simple relief valve without a SIF), and if the scenario is not covered by the situations mentioned above, then the following applied:

a) LOPA was not completed;

b) Where LOPA was performed, then any additional SIFs are subject to approval by the TA1 in Technical Safety of the Principal or the Business.

LOPA was not performed where there was no SIF as a safeguard and the risk was well understood and safeguarded as per DEP / industrial standards / good practices (e.g. what is indicated in the process guide, what is commonly applied in similar units). An example of this approach is an overpressure scenario safeguarded with a valid barrier and an adequately sized relief valve).

- It was ensured that all scenarios were safeguarded as per Shell / industry standards and good practices to demonstrate ALARP. Please note, DEP may cover part of the safeguarding, additional safeguards may be addressed in another DEP. A good example is the double seals requirement for a pump in hazardous service. As double seals can fail, additional safeguards such as fire detection by polyflow activating the sprinkler may be needed, which is addressed in another DEP.
- ALARP demonstration text was always noted in HAZOP/LOPA worksheets for yellow and red risks.
- When the LOPA was completed, an ALARP assessment was performed after achieving tolerable risk in LOPA worksheet and ALARP considerations were written down (or alternatively actions specified for tolerable / ALARP).
- When LOPA was not carried out, an ALARP demonstration was written in the ALARP column of the HAZOP worksheet, to show how ALARP was demonstrated (incl. reference to Shell / industry standard claimed) and (if applicable) which actions were required to meet ALARP.

2.2 Ground Rules and Assumptions

2.2.1 Safeguards / Barriers

The following definitions were applied when identifying barriers in the HAZOP:

- Barriers are engineered systems or administrative controls designed to prevent the causes or mitigate the consequences of deviations (e.g., process alarms, process controls, interlocks, SIFs); and
- Barriers were only be taken into account if they are part of the design (e.g., already part of the design hardware, documentation or operating procedures).

The barriers identified satisfied the following criteria, so as to be considered valid:

- Effective;
- Independent;
- Auditable; and.
- Dependable (applicable for Safety Instrumented Functions (SIFs) only - being designed, implemented, maintained, inspected and tested in accordance with IEC 61511.

In the HAZOP all safeguards (barriers) were listed, both valid and non-valid. Barrier validity was recorded in the HAZOP for yellow and red risks. Where a safeguard was identified as non-valid then the reason why was recorded. When the barrier was identified as valid, the checks made to ascertain validity were recorded, e.g., nature of operator response (e.g. tag of the valve that the operator will close), which operator (field or control room) will act (when the initiating event is a human error), sufficient time for operator response, direction of failure of the valve for a control loop barrier, sensors and final elements for SIFs, clean service, etc.

Control actions for those BPCS loops (in or outside the unit being considered) that detect the deviation caused by the initiating event and react to it to restore normal conditions/resolve the upset were recorded as barriers in the HAZOP. Example: a level control loop in a vessel of which the inlet control valve fails open. Barrier validity was assessed.

Control actions for those BPCS loops (in or outside the unit being considered) that do not detect the deviation caused by the initiating event and (therefore) do not react to it to restore normal conditions/resolve the upset are considered independent from the initiating event (of course only if they also have independent sensors and final elements). Example: a steam system pressure control loop is independent from the reflux control loop in the column the steam is used as reboiler medium.

The challenge of whether the BPCS can be claimed as an Independent Protection Layer (IPL), in accordance with the Shell LOPA DEP [Ref. 1] was carried out in the HAZOP.

The challenge of whether the alarm can be claimed as an IPL, in accordance with the Shell LOPA DEP, was carried out in the HAZOP.

As shown in Figure 4, a scenario may have one or more protection layers of various types, depending on the complexity of a process and the potential severity of the consequences. A LOPA provides a consistent basis to judge whether there are sufficient IPLs against hazardous events to achieve the required risk reduction target. A LOPA considers only IPLs whereas a HAZOP may include safeguards that are not IPLs.

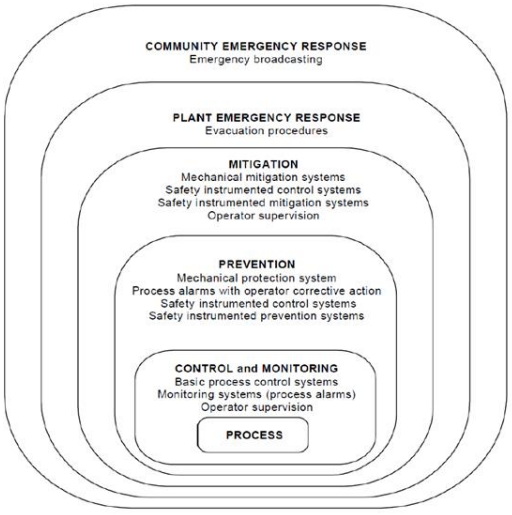


Figure 4: Typical Protection Layers found in Process Plants

2.2.2 SIFs

Only the final elements for each respective SIF which prevent the consequence were recorded, i.e. if the C&Es identifies several executive actions, only the primary actions which prevent the consequence were recorded against the SIF.

If a SIF was considered for a particular consequence (e.g. overpressure) but the SIF design intent did not include the consequence being discussed (e.g. prevent sending liquid to furnace), the SIF was recorded in the HAZOP but the threat to consequence line did not take part in the LOPA to determine the SIL of the SIF. The SIF design intent was recorded. If the final element that would be effective for the consequence being considered (e.g. valve in inlet) is not a primary final element (in SIFPro), the SIF was not considered valid for the particular consequence.

2.2.3 Relief Valves

The following information was recorded for relief valves:

- Set points; and
- Correctly sized for the over-pressure event, with documentary evidence.

Passing relief valves were not taken as a "cause" unless the relief valve discharges to atmosphere.

2.2.4 Over-Pressure Consequences

In accordance with the Shell LOPA DEP, the HAZOP Team recorded over-pressure consequences as follows:

1. Consequence of rupture – this was allocated the highest severity;
2. Consequence of flange leak – allocated with a lower severity.

Recording the consequences allowed the probability of rupture to be identified in the LOPA in accordance with the data in Table 1 and the leak hole size in accordance with the data in Table 2.

The consequence was written to clearly indicate the design pressure and the maximum pressure generated from the upset case so that over-pressure ratio can be clearly seen.

A suitably sized relief valve is the default minimum safeguarding solution for overpressure cases. Only if implementing an adequate relief system is not practicable, an alternative design approach may be adopted. See Shell Overpressure DEP [Ref. 2] Section 2.10.3 for definition of what is not practicable and for an alternative safeguarding approach. It was not the purpose of the HAZOP or LOPA to design safeguarding systems.

Table 1: Probability of Rupture

Vessel Design Code	Safety Factor	Probability of equipment rupture (Note 1)		
		Prob = 0.01	Prob = 0.1	Prob = 1.0
ASME Section VIII Pre-2000	4:1	2.8≤PR<3.2	3.2≤PR<3.6	3.6≤PR
ASME Section VIII 2000 and newer	3.5:1	2.5≤PR<2.8	2.8≤PR<3.2	3.2≤PR
ASME Section VIII Div 2, Stoomwezen, or CODAP	3:1	2.2≤PR<2.4	2.4≤PR<2.7	2.7≤PR
EN-13445	2.4:1	1.8≤PR<2.0	2.0≤PR<2.2	2.2≤PR
AS-1210 or PD5500	2.35:1	1.8≤PR<2.0	2.0≤PR<2.2	2.2≤PR

Table 2: Flange Hole Size

Vessel Design Code	Safety Factor	Pressure/MAWP ratio or design pressure (PR) that results in hole of given diameter (probability = 1) (Note 1)		
		7 mm (0.28 in) (Note 2)	25mm (1 in.)	100mm (4 in.) (Note 3)
ASME Section VIII Pre-2000	4:1	cHTP≤PR<1.9	1.9≤PR<3	3≤PR<3.6
ASME Section VIII 2000 and newer	3.5:1	cHTP ≤PR<1.9	1.9≤PR<2.7	2.7≤PR<3.2
ASME Section VIII Div 2, Stoomwezen, or CODAP	3:1	cHTP ≤PR<1.9	1.9≤PR<2.5	2.5≤PR<2.7
EN-13445	2.4:1	cHTP ≤PR<1.9	1.9≤PR<2.1	2.1≤PR<2.2
AS-1210 or PD5500	2.35:1	cHTP ≤PR<1.9	1.9 ≤PR<2.1	2.1 ≤PR<2.2

NOTES:

1. PR = Pressure ratio, this being the ratio of [vessel over-pressure] to [MAWP or design pressure].
2. cHTP = corrected Hydrotest Pressure= actual hydrotest pressure corrected for relief scenario or design temperature.
3. beyond the value of PR given in the 100mm (4 in) diameter hole size column, there is no need to assess a leak case as the probability for equipment rupture is considered to be 1 (i.e., leak case will not be determining).

2.2.5 Locked Manual Valves

If inadvertent closure of a Locked Open (LO) valve causes "immediate" overpressure, verify compliance with ASME VIII Appendix M (North America) or corresponding (outside North America) Shell interpretation (single valve with or without lock is normally not accepted as an open system if closure of that valve can create an immediate overpressure case greater than 110% of the design pressure).

For locked valves, 2 human errors could occur:

1. The operator has intentionally operated the locked valve (e.g. for shutdown/start-up) and forgot to re-instate it in its normal, locked position. In this case, the lock is not a barrier since the valve was intentionally operated. Operating a locked valve should follow a procedure and therefore initiating event frequencies can be calculated based on LOPA DEP Table 5 and the expected frequency of operation of the locked valve. For this, it was important to understand why the valve was implemented and why it needs to be operated. It is quite different to have a valve that was put for construction purposes only and will never be operated versus a valve that will be used for some special modes of operation.
2. Inadvertent operation of the wrong valve. Operator should close valve B but closes valve A instead. In this case, the lock is a barrier with PFD=0.1 as per LOPA DEP Table 2 Row 25 (Keyed Bypass /Interlock). In this case, the frequency of operation of the "other/right" valve (in this example valve B) was considered. This could be a valve physically nearby or a valve on a parallel string/train.

In cases where the human error related to the locked valve is another reason for e.g. a path to be closed, it may not be significant mathematically (in a LOPA/SIF classification). However, it may be quite important to look at if the locked valve is not the only cause for the scenario to develop.

3 WORKSHOP

3.1 Workshop TOR

The LOPA workshop was conducted in accordance with the scope, objectives and methodology as defined in the LOPA Terms of Reference (TOR) [Ref 3].

3.2 Workshop Schedule

The LOPA workshop was conducted on the 1st December 2023.

The workshop was carried out face-to-face at the Rosetti Marino office in Milan, Italy with a number of personnel joining the workshop virtually using Microsoft Teams.

Due to time constraints, the full Rosetti scope which included analysis of the package units was not completed during the programmed HAZOP workshops. All of the equipment which was determined by the workshop team to be capable of causing a MAH (based on review of the risk rankings within the project Hazard and Effect Register) was analysed during the workshops.

Additional time will be required to fully complete the HAZOP of the package units, and a final check for any additional LOPA requirements should be performed once the workshops have been completed.

3.3 Workshop Attendees

The workshop was attended by a multidisciplinary team who provided input through their expertise on different aspects of the process. A list of attendance for each day of the preceding HAZOP workshop, and the LOPA workshop are included in Appendix E.

3.4 Reference Documents

The documents presented in Table 3 and Table 4 were used / referenced for the LOPA workshop.

Table 3: DEFINE LOPA Documents

Document Number	Rev	Description
123A90-DDL-IN-CE-40000	00	Process Safety Cause & Effect Matrix
123A90-DDL-SAF-RE-30046	02	HSE Design Philosophy

The Process Engineering Flow Sheets (PEFS) listed were marked-up with nodes and studied in the HAZOP workshop. They are contained within Appendix A and are listed in Table 4.

Table 4: List of Unit PFD, UFD and PEFS

Document Number	Rev	Description
123A90-DDL-PR-PID-80009	00	GENERAL NOTES
123A90-DDL-PR-PID-80010	00	PIPING SYMBOLOGY
123A90-DDL-PR-PID-80011	00	ELECTROLYSER PACKAGE
123A90-DDL-PR-PID-80011	00	ELECTROLYSER PACKAGE
123A90-DDL-PR-PID-80012	00	FUEL CELL PACKAGE
123A90-DDL-PR-PID-80013	00	HYDROGEN STORAGE VESSELS HEADER (INLET)
123A90-DDL-PR-PID-80014	00	HYDROGEN STORAGE VESSELS HEADER (OUTLET)
123A90-DDL-PR-PID-80015	00	HYDROGEN STORAGE VESSEL A
123A90-DDL-PR-PID-80016	00	HYDROGEN STORAGE VESSEL B
123A90-DDL-PR-PID-80017	00	HYDROGEN STORAGE VESSEL C
123A90-DDL-PR-PID-80018	00	HYDROGEN STORAGE VESSEL D
123A90-DDL-PR-PID-80019	00	HYDROGEN STORAGE VESSEL E

Document Number	Rev	Description
123A90-DDL-PR-PID-80020	00	HYDROGEN STORAGE VESSEL F
123A90-DDL-PR-PID-80021	00	SEA-WATER INTAKE SYSTEM SHEET 1
123A90-DDL-PR-PID-80022	00	SEA-WATER INTAKE SYSTEM SHEET 2
123A90-DDL-PR-PID-80023	00	WATER TREATMENT PLANT SHEET 1
123A90-DDL-PR-PID-80024	00	WATER TREATMENT PLANT SHEET 2
123A90-DDL-PR-PID-80025	00	WATER DISPOSAL SHEET 1
123A90-DDL-PR-PID-80026	00	WATER DISPOSAL SHEET 2
123A90-DDL-PR-PID-80027	00	INSTRUMENT AIR PACKAGE
123A90-DDL-PR-PID-80028	00	HYDROGEN VENT HEADER
123A90-DDL-PR-PID-80029	00	HYDROGEN VENT DRUM
123A90-DDL-PR-PID-80041	00	INSTRUMENTATION AND DISTRIBUTION HEADER
123A90-DDL-PR-PID-80042	00	INSTRUMENTATION SYMBOLOGY

4 FINDINGS

4.1 LOPA Worksheets

The completed LOPA worksheet is included in Appendix B, which includes the findings of the LOPA study for each scenario sent to LOPA. The SIF Summation sheet which determines the RRF requirements of any SIFs identified in the LOPA analyses is included in Appendix C.

4.2 HAZOP Worksheet

The HAZOP study was integrated with the LOPA, for which a separate HAZOP report has been issued [Ref. 4].

4.3 LOPA Recommendations

Recommendations raised in the LOPA workshop are included in Appendix F, and are also included in the full list of recommendations given in the HAZOP report [Ref. 4]. These recommendations should be closed-out and tracked in a HSSE Action Tracking Register and Close out report, doc. No. 123A90-DDL-SAF-RE-30007 by Rosetti Marina. Each action-sheet should state the recommendation, the party responsible for closing the action, and the action showing how the recommendation is properly closed.

Where design changes are implemented, the HAZOP and LOPA worksheets should be revisited to ensure the recommendation has been fully met and that all reasonably foreseeable risks associated with the system are managed to an acceptable level.

4.4 Further Work

Due to time constraints, the full Rosetti scope which included analysis of the package units was not completed during the programmed HAZOP workshops. All of the equipment which was determined by the workshop team to be capable of causing a MAH (based on review of the risk rankings within the project Hazard and Effect Register) was analysed during the workshops.

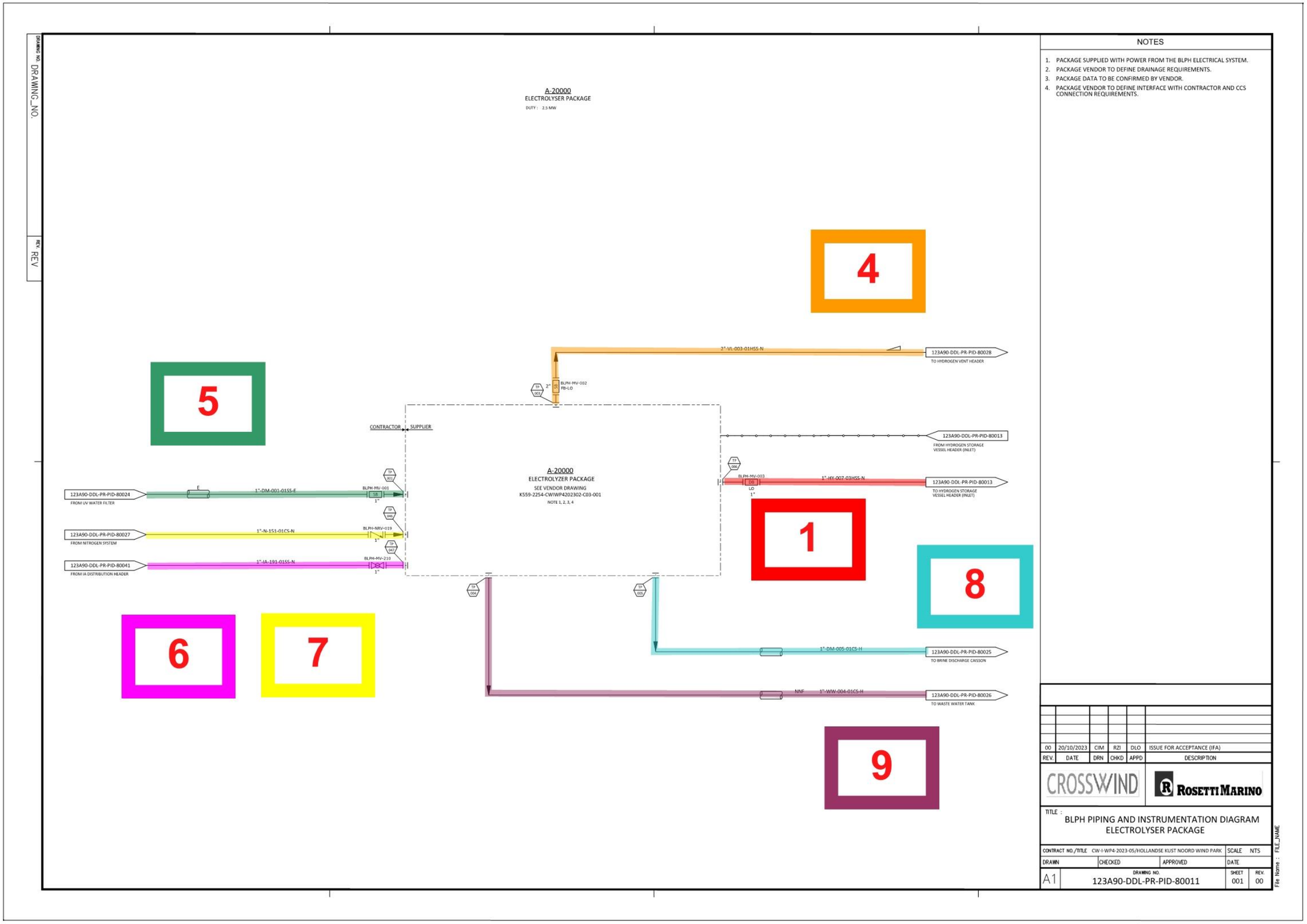
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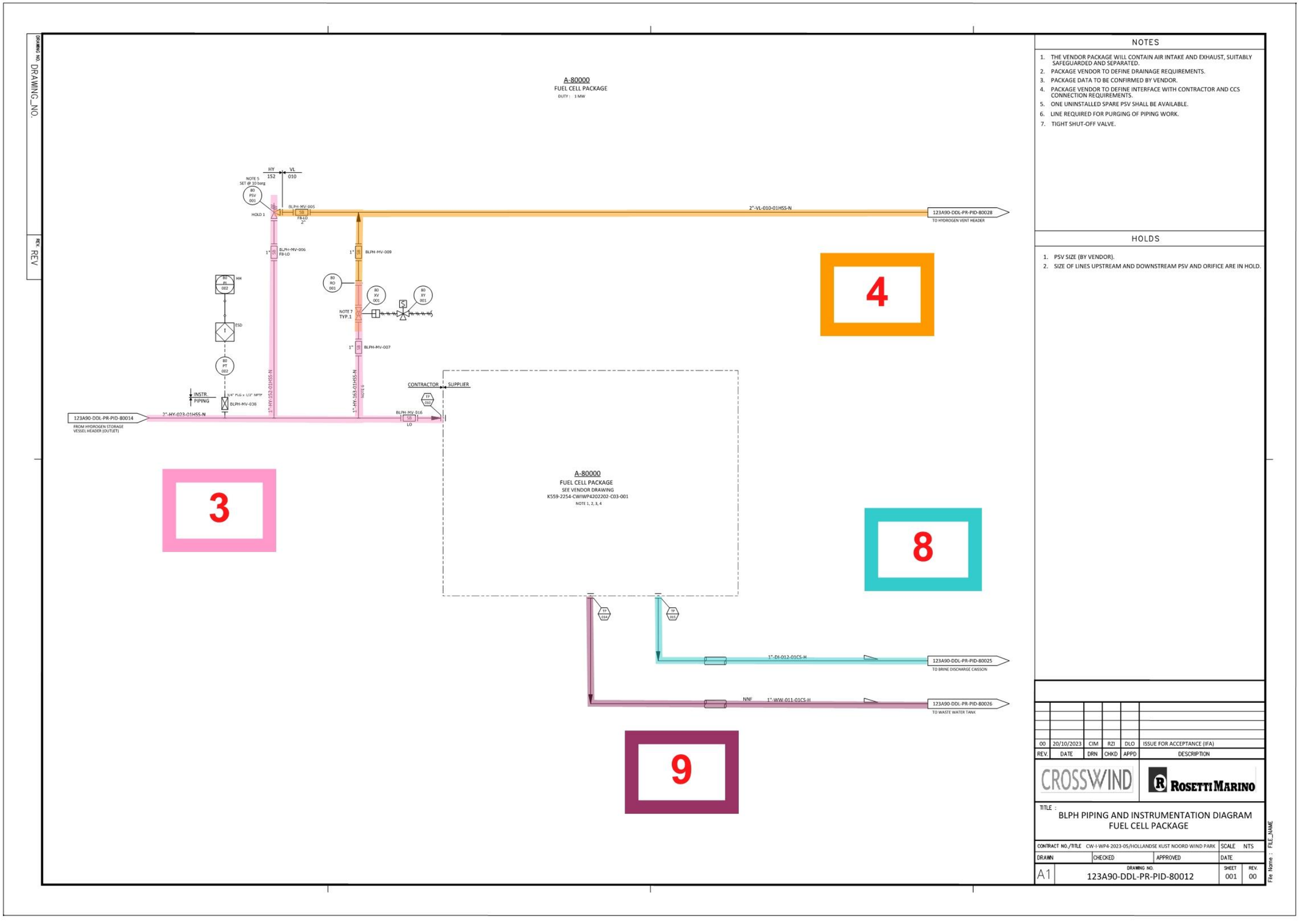
5 REFERENCES

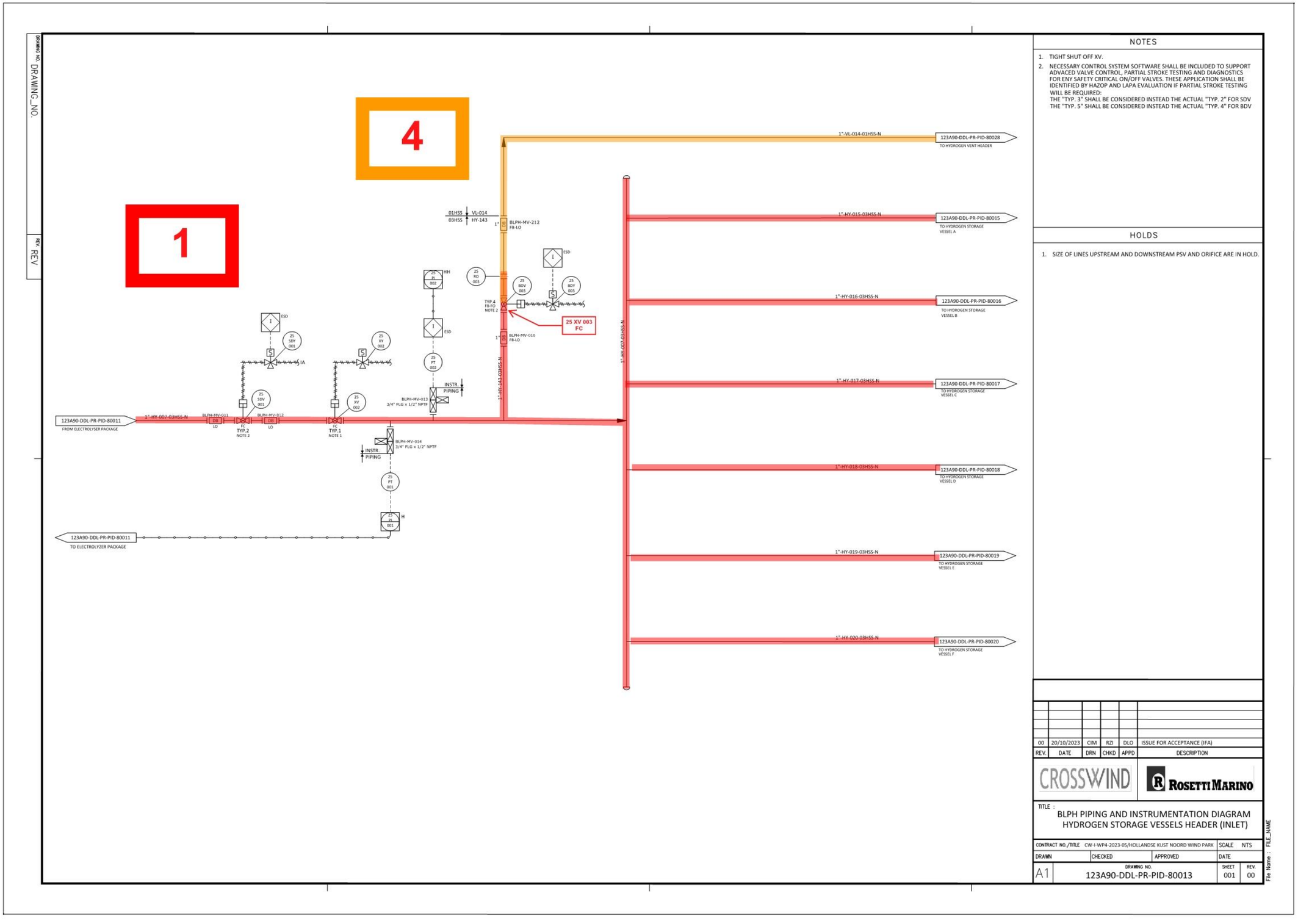
Ref Title

1. Shell, *Layers of Protection Analysis (LOPA)*
   DEP 01.00.02.13. Feb 2021
2. Shell, *Overpressure and Underpressure – Prevention and Protection*
   DEP 80.45.10.11-Gen. Feb 2021
3. Crosswind / Rosetti Marino, *Base Load Power Hub (BLPH): LOPA Terms of Reference*
   123A90-DDL-SAF-RE-30035. 14/11/2023
4. Crosswind / Rosetti Marino, *Base Load Power Hub (BLPH): HAZOP Report*
   123A90-DDL-SAF-RE-30006. 18/12/2023

Appendix A MARKED UP P&IDS


DRAWING_NO.
REV.
A-20000
ELECTROLYSER PACKAGE
DUTY : 2.5 MW
4
5
2"-VL-003-01HSS-N
123A90-DDL-PR-PID-80028
TO HYDROGEN VENT HEADER
BLPH-MV-002
FB-LO
CONTRACTOR
SUPPLIER
123A90-DDL-PR-PID-80013
FROM HYDROGEN STORAGE VESSEL HEADER (INLET)
A-20000
ELECTROLYZER PACKAGE
SEE VENDOR DRAWING
K559-2254-CW1WP4202302-C03-001
NOTE 1, 2, 3, 4
BLPH-MV-003
1"-HY-007-03HSS-N
123A90-DDL-PR-PID-80013
TO HYDROGEN STORAGE VESSEL HEADER (INLET)
123A90-DDL-PR-PID-80024
FROM UV WATER FILTER
1"-DM-001-01SS-E
BLPH-HV-001
123A90-DDL-PR-PID-80027
FROM NITROGEN SYSTEM
1"-N-151-01CS-N
BLPH-NRV-019
123A90-DDL-PR-PID-80041
FROM IA DISTRIBUTION HEADER
1"-IA-191-01SS-N
BLPH-MV-210
1
8
6
7
1"-DM-005-01CS-H
123A90-DDL-PR-PID-80025
TO BRINE DISCHARGE CAISSON
NNF
1"-WW-004-01CS-H
123A90-DDL-PR-PID-80026
TO WASTE WATER TANK
9
NOTES
1. PACKAGE SUPPLIED WITH POWER FROM THE BLPH ELECTRICAL SYSTEM.
2. PACKAGE VENDOR TO DEFINE DRAINAGE REQUIREMENTS.
3. PACKAGE DATA TO BE CONFIRMED BY VENDOR.
4. PACKAGE VENDOR TO DEFINE INTERFACE WITH CONTRACTOR AND CCS CONNECTION REQUIREMENTS.
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
ELECTROLYSER PACKAGE
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN CHECKED APPROVED DATE
A1
DRAWING NO. 123A90-DDL-PR-PID-80011
SHEET 001
REV. 00
File Name : FILE_NAME


DRAWING_NO.
REV.
A-80000
FUEL CELL PACKAGE
DUTY : 1 MW
HY 152
VL 010
NOTE 5
SET @ 10 barg
80 PSV 001
HOLD 1
BLPH-MV-005
FB-LO
2"
2"-VL-010-01HSS-N
123A90-DDL-PR-PID-80028
TO HYDROGEN VENT HEADER
BLPH-MV-006
FB-LO
1"
BLPH-MV-009
80 RO 001
80 XV 001
80 XY 001
NOTE 7
TYP.1
80 FE 002
MM
ESD
80 PT 002
INSTR. PIPING
1/4" PLG x 1/2" NPT
BLPH-MV-038
1"-HY-152-01HSS-N
1"-HY-163-01HSS-N
NOTE 6
BLPH-MV-007
CONTRACTOR
SUPPLIER
TP 003
BLPH-MV-016
LO
123A90-DDL-PR-PID-80014
FROM HYDROGEN STORAGE VESSEL HEADER (OUTLET)
2"-HY-023-01HSS-N
A-80000
FUEL CELL PACKAGE
SEE VENDOR DRAWING
K559-2254-CWIWP4202202-C03-001
NOTE 1, 2, 3, 4
TP 154
TP 155
1"-DI-012-01CS-H
123A90-DDL-PR-PID-80025
TO BRINE DISCHARGE CAISSON
NNF
1"-WW-011-01CS-H
123A90-DDL-PR-PID-80026
TO WASTE WATER TANK
4
3
8
9
NOTES
1. THE VENDOR PACKAGE WILL CONTAIN AIR INTAKE AND EXHAUST, SUITABLY SAFEGUARDED AND SEPARATED.
2. PACKAGE VENDOR TO DEFINE DRAINAGE REQUIREMENTS.
3. PACKAGE DATA TO BE CONFIRMED BY VENDOR.
4. PACKAGE VENDOR TO DEFINE INTERFACE WITH CONTRACTOR AND CCS CONNECTION REQUIREMENTS.
5. ONE UNINSTALLED SPARE PSV SHALL BE AVAILABLE.
6. LINE REQUIRED FOR PURGING OF PIPING WORK.
7. TIGHT SHUT-OFF VALVE.
HOLDS
1. PSV SIZE (BY VENDOR).
2. SIZE OF LINES UPSTREAM AND DOWNSTREAM PSV AND ORIFICE ARE IN HOLD.
00 | 20/10/2023 | CIM | RZI | DLO | ISSUE FOR ACCEPTANCE (IFA)
REV. | DATE | DRN | CHKD | APPD | DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
FUEL CELL PACKAGE
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN | CHECKED | APPROVED | DATE
A1
DRAWING NO. 123A90-DDL-PR-PID-80012
SHEET 001
REV. 00
File Name : FILE_NAME



NOTES

1. TIGHT SHUT OFF XV.
2. NECESSARY CONTROL SYSTEM SOFTWARE SHALL BE INCLUDED TO SUPPORT ADVACED VALVE CONTROL, PARTIAL STROKE TESTING AND DIAGNOSTICS FOR ENY SAFETY CRITICAL ON/OFF VALVES. THESE APPLICATION SHALL BE IDENTIFIED BY HAZOP AND LAPA EVALUATION IF PARTIAL STROKE TESTING WILL BE REQUIRED.
   THE "TYP. 3" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 2" FOR SDV
   THE "TYP. 5" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 4" FOR BDV

HOLDS

1. SIZE OF LINES UPSTREAM AND DOWNSTREAM PSV AND ORIFICE ARE IN HOLD.

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
00	20/10/2023	CIM	RZI	DLO	ISSUE FOR ACCEPTANCE (IFA)

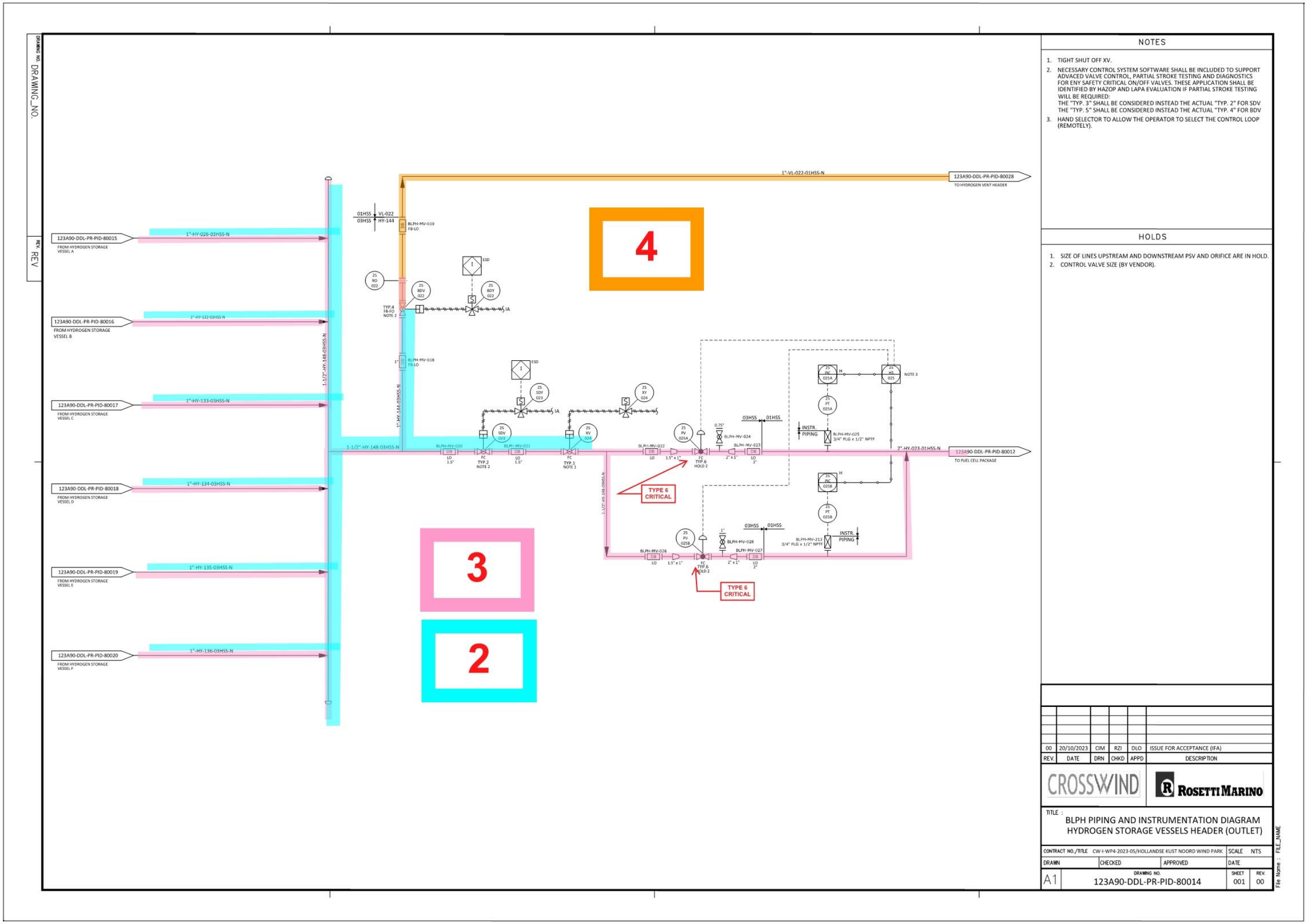
CROSSWIND | ROSETTI MARINO

TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
HYDROGEN STORAGE VESSELS HEADER (INLET)

CONTRACT NO./TITLE	CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK	SCALE	NTS
DRAWN	CHECKED	APPROVED	DATE

A1	DRAWING NO. 123A90-DDL-PR-PID-80013	SHEET 001	REV. 00

DRAWING_NO.
REV.
File Name : FILE_NAME



NOTES

1. TIGHT SHUT OFF XV.
2. NECESSARY CONTROL SYSTEM SOFTWARE SHALL BE INCLUDED TO SUPPORT ADVACED VALVE CONTROL, PARTIAL STROKE TESTING AND DIAGNOSTICS FOR ENY SAFETY CRITICAL ON/OFF VALVES. THESE APPLICATION SHALL BE IDENTIFIED BY HAZOP AND LAPA EVALUATION IF PARTIAL STROKE TESTING WILL BE REQUIRED:
   THE "TYP. 3" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 2" FOR SDV
   THE "TYP. 5" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 4" FOR BDV
3. HAND SELECTOR TO ALLOW THE OPERATOR TO SELECT THE CONTROL LOOP (REMOTELY).

HOLDS

1. SIZE OF LINES UPSTREAM AND DOWNSTREAM PSV AND ORIFICE ARE IN HOLD.
2. CONTROL VALVE SIZE (BY VENDOR).

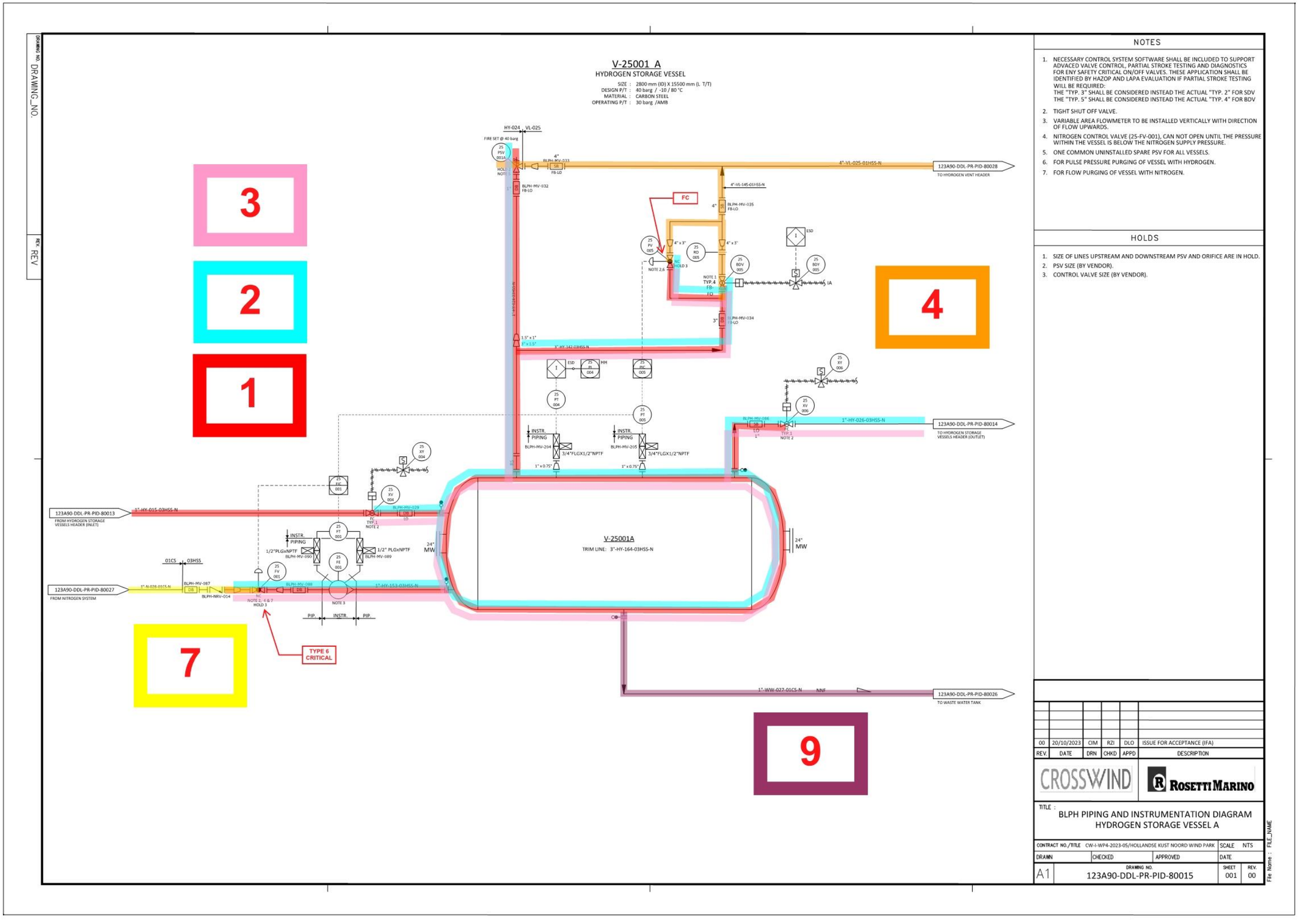
REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
00	20/10/2023	CIM	RZI	DLO	ISSUE FOR ACCEPTANCE (IFA)

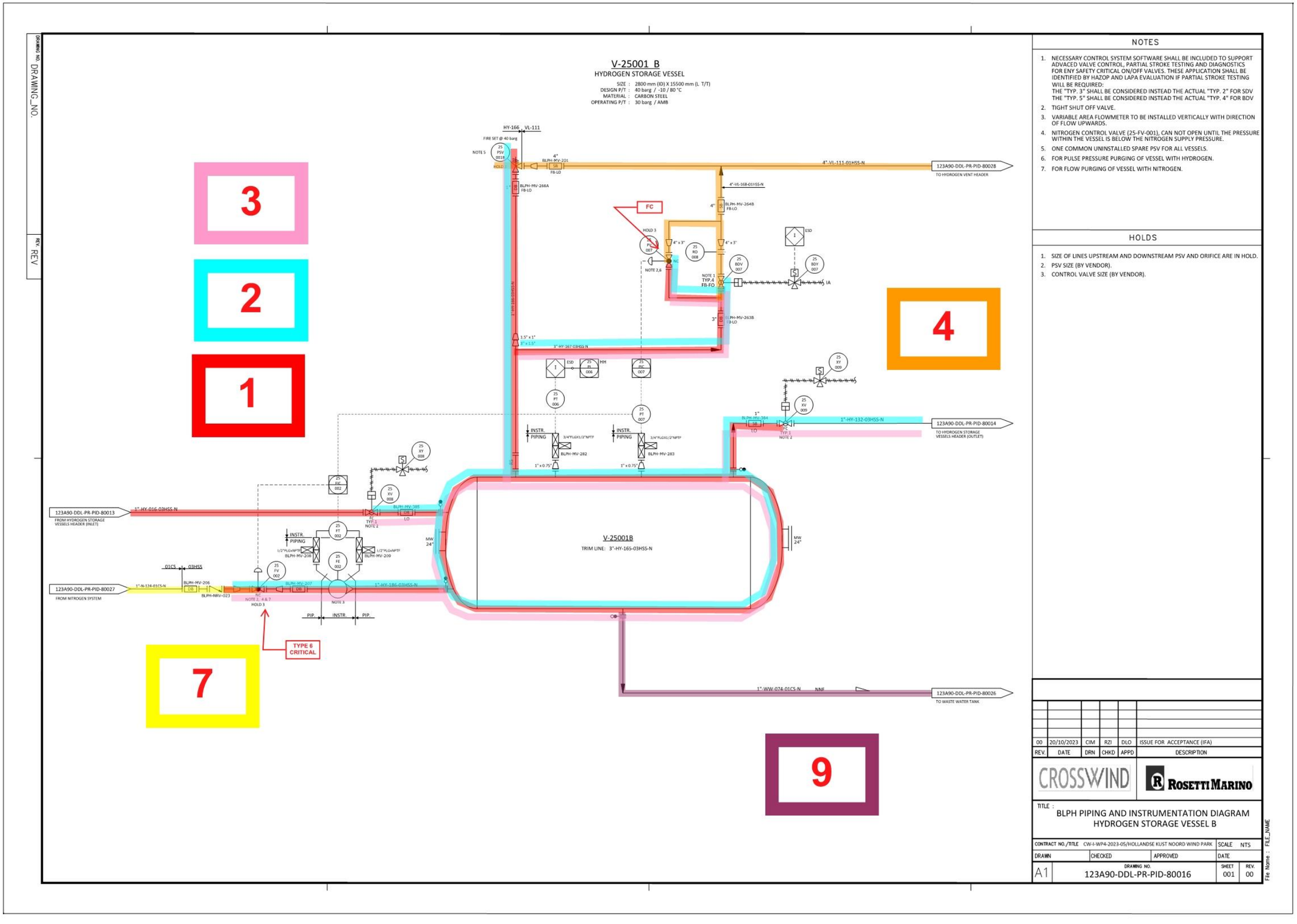
CROSSWIND — ROSETTI MARINO

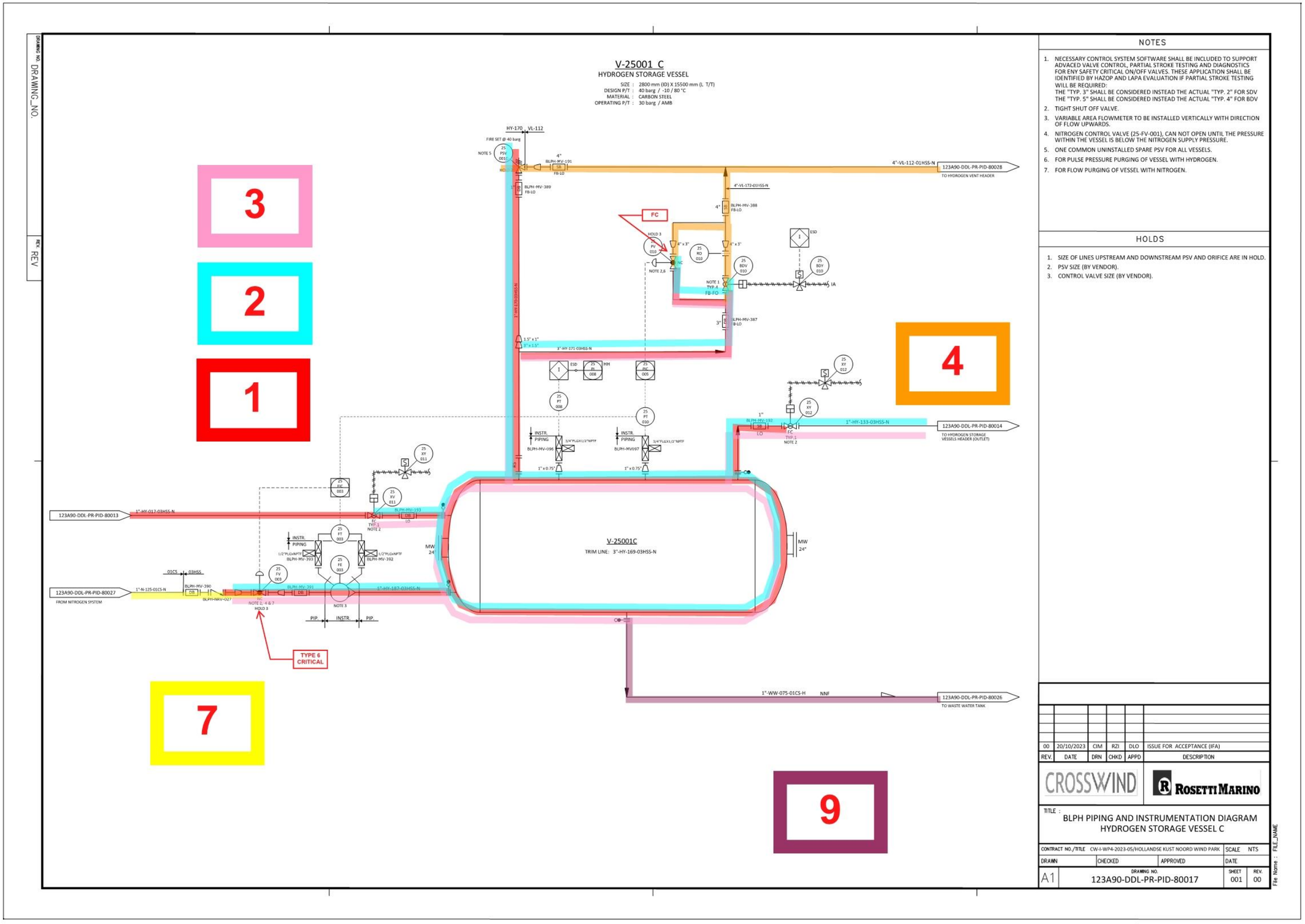
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
HYDROGEN STORAGE VESSELS HEADER (OUTLET)

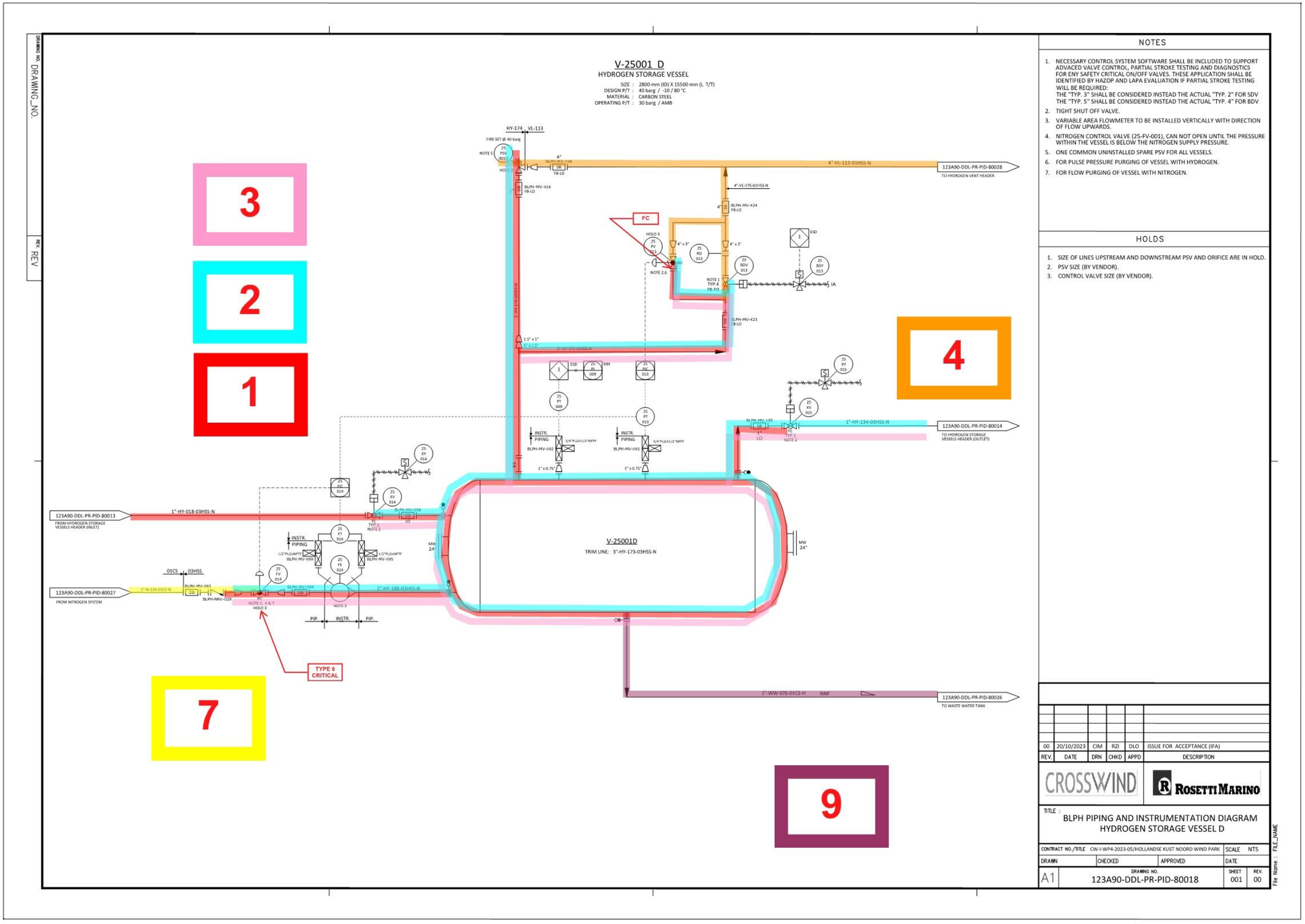
CONTRACT NO./TITLE	CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK	SCALE	NTS
DRAWN	CHECKED	APPROVED	DATE
A1	DRAWING NO. 123A90-DDL-PR-PID-80014	SHEET 001	REV. 00

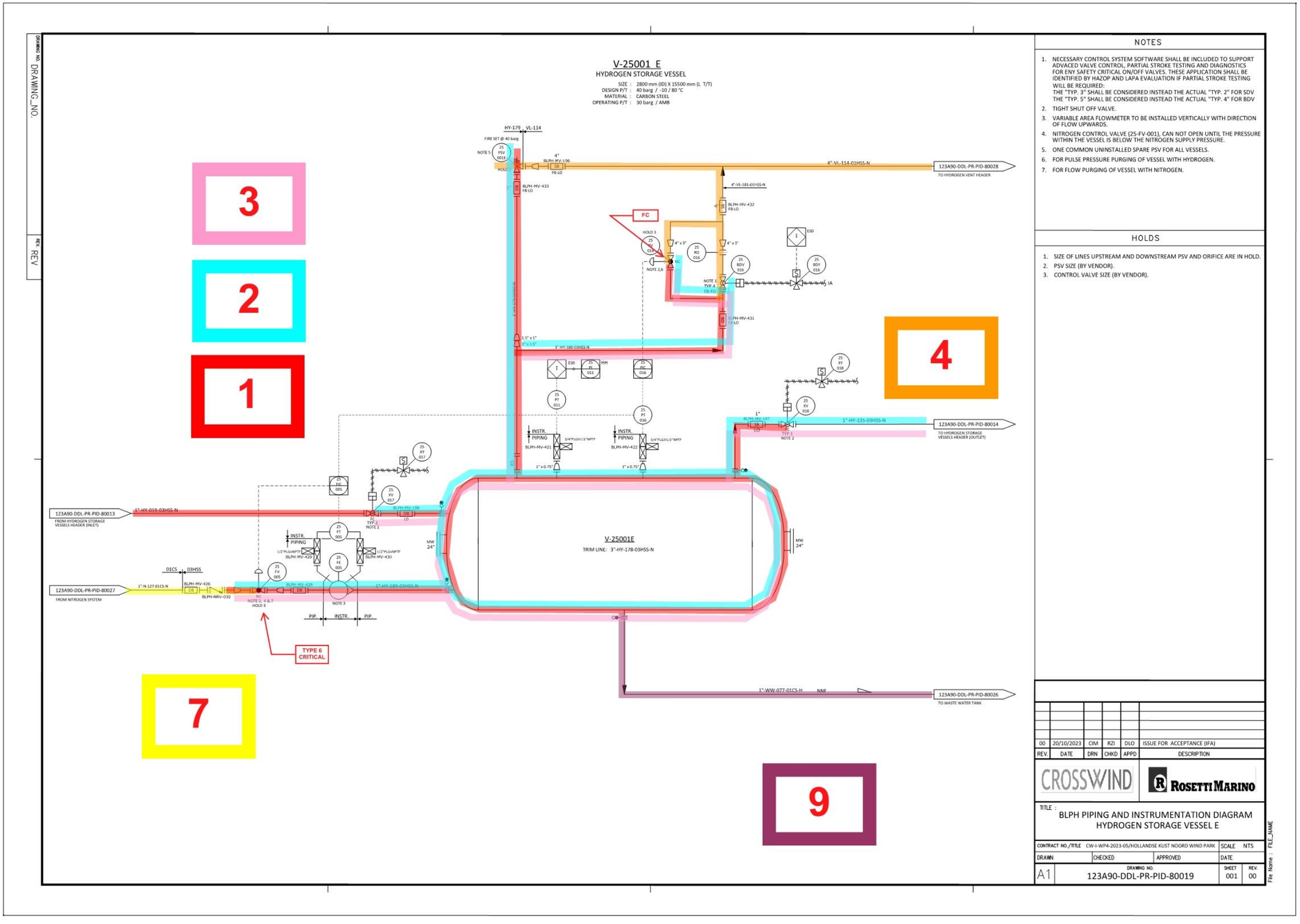
File Name : FILE_NAME

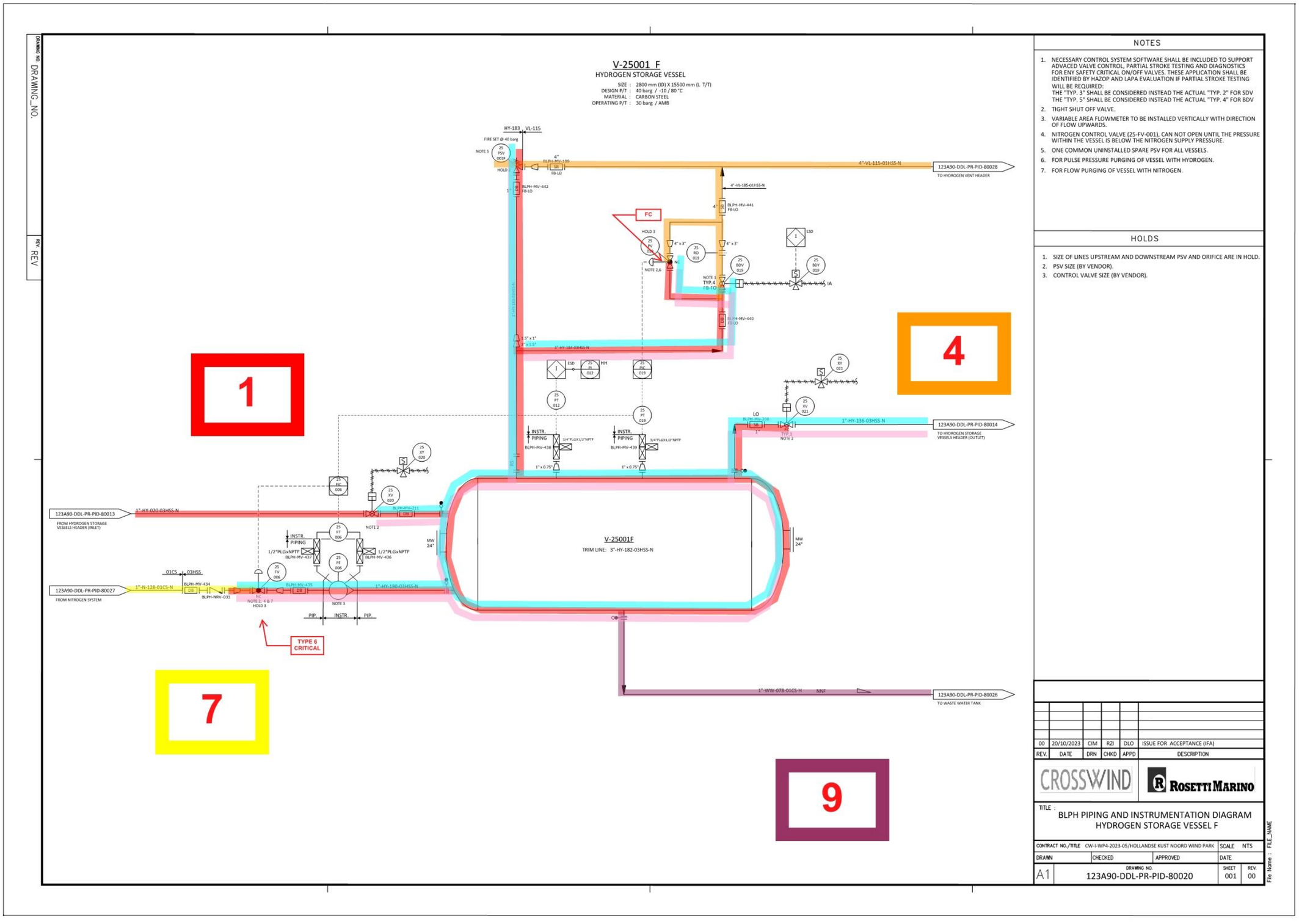

DRAWING_NO.
REV.
V-25001 A
HYDROGEN STORAGE VESSEL
SIZE : 2800 mm (ID) X 15500 mm (L T/T)
DESIGN P/T : 40 barg / -10 / 80 °C
MATERIAL : CARBON STEEL
OPERATING P/T : 30 barg /AMB
HY-024 , VL-025
FIRE SET @ 40 barg
4"-VL-025-01HSS-N
123A90-DDL-PR-PID-80028
TO HYDROGEN VENT HEADER
4"-VL-145-01HSS-N
BLPH-MV-033
BLPH-MV-032
BLPH-MV-035
FC
BLPH-MV-034
1"-HY-142-03HSS-N
1"-HY-026-03HSS-N
123A90-DDL-PR-PID-80014
TO HYDROGEN STORAGE VESSELS HEADER (OUTLET)
BLPH-MV-086
INSTR. PIPING
BLPH-MV-204
BLPH-MV-205
3/4"FLGX1/2"NPTF
123A90-DDL-PR-PID-80013
FROM HYDROGEN STORAGE VESSELS HEADER (INLET)
1"-HY-015-03HSS-N
BLPH-MV-029
V-25001A
TRIM LINE: 3"-HY-164-03HSS-N
24" MW
1/2"PLGxNPTF
BLPH-MV-090
BLPH-MV-089
01CS
03HSS
123A90-DDL-PR-PID-80027
FROM NITROGEN SYSTEM
1"-N-028-01CS-N
BLPH-MV-087
BLPH-NRV-014
BLPH-MV-088
1"-HY-153-03HSS-N
TYPE 6 CRITICAL
1"-WW-027-01CS-N
123A90-DDL-PR-PID-80026
TO WASTE WATER TANK
3
2
1
4
7
9
NOTES
1. NECESSARY CONTROL SYSTEM SOFTWARE SHALL BE INCLUDED TO SUPPORT ADVACED VALVE CONTROL, PARTIAL STROKE TESTING AND DIAGNOSTICS FOR ENY SAFETY CRITICAL ON/OFF VALVES. THESE APPLICATION SHALL BE IDENTIFIED BY HAZOP AND LAPA EVALUATION IF PARTIAL STROKE TESTING WILL BE REQUIRED:
THE "TYP. 3" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 2" FOR SDV
THE "TYP. 5" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 4" FOR BDV
2. TIGHT SHUT OFF VALVE.
3. VARIABLE AREA FLOWMETER TO BE INSTALLED VERTICALLY WITH DIRECTION OF FLOW UPWARDS.
4. NITROGEN CONTROL VALVE (25-FV-001), CAN NOT OPEN UNTIL THE PRESSURE WITHIN THE VESSEL IS BELOW THE NITROGEN SUPPLY PRESSURE.
5. ONE COMMON UNINSTALLED SPARE PSV FOR ALL VESSELS.
6. FOR PULSE PRESSURE PURGING OF VESSEL WITH HYDROGEN.
7. FOR FLOW PURGING OF VESSEL WITH NITROGEN.
HOLDS
1. SIZE OF LINES UPSTREAM AND DOWNSTREAM PSV AND ORIFICE ARE IN HOLD.
2. PSV SIZE (BY VENDOR).
3. CONTROL VALVE SIZE (BY VENDOR).
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
HYDROGEN STORAGE VESSEL A
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN CHECKED APPROVED DATE
A1
DRAWING NO. 123A90-DDL-PR-PID-80015
SHEET 001
REV. 00
File Name :- FILE_NAME


V-25001 B
HYDROGEN STORAGE VESSEL
SIZE : 2800 mm (ID) X 15500 mm (L T/T)
DESIGN P/T : 40 barg / -10 / 80 °C
MATERIAL : CARBON STEEL
OPERATING P/T : 30 barg / AMB
HY-166 VL-111
FIRE SET @ 40 barg
4"-VL-111-01HSS-N
123A90-DDL-PR-PID-80028
TO HYDROGEN VENT HEADER
4"-VL-168-01HSS-N
BLPH-MV-264B
FB-LO
FC
BLPH-MV-266A
FB-LO
BLPH-MV-263B
FB-LO
1"-HY-267-03HSS-N
1"-HY-132-03HSS-N
123A90-DDL-PR-PID-80014
TO HYDROGEN STORAGE VESSELS HEADER (OUTLET)
BLPH-MV-282
BLPH-MV-283
1"-HY-016-03HSS-N
123A90-DDL-PR-PID-80013
FROM HYDROGEN STORAGE VESSELS HEADER (INLET)
BLPH-MV-285
V-25001B
TRIM LINE: 3"-HY-165-03HSS-N
BLPH-MV-208
BLPH-MV-209
BLPH-MV-206
BLPH-MV-207
1"-N-124-01CS-N
123A90-DDL-PR-PID-80027
FROM NITROGEN SYSTEM
1"-HY-186-03HSS-N
TYPE 6 CRITICAL
1"-WW-074-01CS-N
123A90-DDL-PR-PID-80026
TO WASTE WATER TANK
3
2
1
4
7
9
NOTES
1. NECESSARY CONTROL SYSTEM SOFTWARE SHALL BE INCLUDED TO SUPPORT ADVACED VALVE CONTROL, PARTIAL STROKE TESTING AND DIAGNOSTICS FOR ENY SAFETY CRITICAL ON/OFF VALVES. THESE APPLICATION SHALL BE IDENTIFIED BY HAZOP AND LAPA EVALUATION IF PARTIAL STROKE TESTING WILL BE REQUIRED:
THE "TYP. 3" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 2" FOR SDV
THE "TYP. 5" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 4" FOR BDV
2. TIGHT SHUT OFF VALVE.
3. VARIABLE AREA FLOWMETER TO BE INSTALLED VERTICALLY WITH DIRECTION OF FLOW UPWARDS.
4. NITROGEN CONTROL VALVE (25-FV-001), CAN NOT OPEN UNTIL THE PRESSURE WITHIN THE VESSEL IS BELOW THE NITROGEN SUPPLY PRESSURE.
5. ONE COMMON UNINSTALLED SPARE PSV FOR ALL VESSELS.
6. FOR PULSE PRESSURE PURGING OF VESSEL WITH HYDROGEN.
7. FOR FLOW PURGING OF VESSEL WITH NITROGEN.
HOLDS
1. SIZE OF LINES UPSTREAM AND DOWNSTREAM PSV AND ORIFICE ARE IN HOLD.
2. PSV SIZE (BY VENDOR).
3. CONTROL VALVE SIZE (BY VENDOR).
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
HYDROGEN STORAGE VESSEL B
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN CHECKED APPROVED DATE
A1
DRAWING NO. 123A90-DDL-PR-PID-80016
SHEET 001
REV. 00
DRAWING NO.
REV.
File Name :- FILE_NAME


V-25001 C
HYDROGEN STORAGE VESSEL
SIZE : 2800 mm (ID) X 15500 mm (L T/T)
DESIGN P/T : 40 barg / -10 / 80 °C
MATERIAL : CARBON STEEL
OPERATING P/T : 30 barg / AMB
V-25001C
TRIM LINE: 3"-HY-169-03HSS-N
TYPE 6 CRITICAL
NOTES
1. NECESSARY CONTROL SYSTEM SOFTWARE SHALL BE INCLUDED TO SUPPORT ADVACED VALVE CONTROL, PARTIAL STROKE TESTING AND DIAGNOSTICS FOR ENY SAFETY CRITICAL ON/OFF VALVES. THESE APPLICATION SHALL BE IDENTIFIED BY HAZOP AND LAPA EVALUATION IF PARTIAL STROKE TESTING WILL BE REQUIRED:
THE "TYP. 3" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 2" FOR SDV
THE "TYP. 5" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 4" FOR BDV
2. TIGHT SHUT OFF VALVE.
3. VARIABLE AREA FLOWMETER TO BE INSTALLED VERTICALLY WITH DIRECTION OF FLOW UPWARDS.
4. NITROGEN CONTROL VALVE (25-FV-001), CAN NOT OPEN UNTIL THE PRESSURE WITHIN THE VESSEL IS BELOW THE NITROGEN SUPPLY PRESSURE.
5. ONE COMMON UNINSTALLED SPARE PSV FOR ALL VESSELS.
6. FOR PULSE PRESSURE PURGING OF VESSEL WITH HYDROGEN.
7. FOR FLOW PURGING OF VESSEL WITH NITROGEN.
HOLDS
1. SIZE OF LINES UPSTREAM AND DOWNSTREAM PSV AND ORIFICE ARE IN HOLD.
2. PSV SIZE (BY VENDOR).
3. CONTROL VALVE SIZE (BY VENDOR).
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
HYDROGEN STORAGE VESSEL C
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN CHECKED APPROVED DATE
A1
DRAWING NO. 123A90-DDL-PR-PID-80017
SHEET 001
REV. 00
DRAWING NO.
REV.
File Name :- FILE_NAME


V-25001 D
HYDROGEN STORAGE VESSEL
SIZE : 2800 mm (ID) X 15500 mm (L T/T)
DESIGN P/T : 40 barg / -10 / 80 °C
MATERIAL : CARBON STEEL
OPERATING P/T : 30 barg / AMB
V-25001D
TRIM LINE: 3"-HY-173-03HSS-N
123A90-DDL-PR-PID-80028
TO HYDROGEN VENT HEADER
123A90-DDL-PR-PID-80014
TO HYDROGEN STORAGE VESSELS HEADER (OUTLET)
123A90-DDL-PR-PID-80013
FROM HYDROGEN STORAGE VESSELS HEADER (INLET)
123A90-DDL-PR-PID-80027
FROM NITROGEN SYSTEM
123A90-DDL-PR-PID-80026
TO WASTE WATER TANK
TYPE 6 CRITICAL
NOTES
1. NECESSARY CONTROL SYSTEM SOFTWARE SHALL BE INCLUDED TO SUPPORT ADVACED VALVE CONTROL, PARTIAL STROKE TESTING AND DIAGNOSTICS FOR ENY SAFETY CRITICAL ON/OFF VALVES. THESE APPLICATION SHALL BE IDENTIFIED BY HAZOP AND LAPA EVALUATION IF PARTIAL STROKE TESTING WILL BE REQUIRED:
THE "TYP. 3" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 2" FOR SDV
THE "TYP. 5" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 4" FOR BDV
2. TIGHT SHUT OFF VALVE.
3. VARIABLE AREA FLOWMETER TO BE INSTALLED VERTICALLY WITH DIRECTION OF FLOW UPWARDS.
4. NITROGEN CONTROL VALVE (25-FV-001), CAN NOT OPEN UNTIL THE PRESSURE WITHIN THE VESSEL IS BELOW THE NITROGEN SUPPLY PRESSURE.
5. ONE COMMON UNINSTALLED SPARE PSV FOR ALL VESSELS.
6. FOR PULSE PRESSURE PURGING OF VESSEL WITH HYDROGEN.
7. FOR FLOW PURGING OF VESSEL WITH NITROGEN.
HOLDS
1. SIZE OF LINES UPSTREAM AND DOWNSTREAM PSV AND ORIFICE ARE IN HOLD.
2. PSV SIZE (BY VENDOR).
3. CONTROL VALVE SIZE (BY VENDOR).
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
HYDROGEN STORAGE VESSEL D
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN CHECKED APPROVED DATE
A1
DRAWING NO.
123A90-DDL-PR-PID-80018
SHEET 001
REV. 00
File Name :- FILE_NAME
DRAWING NO.
REV.
1
2
3
4
7
9


V-25001 E
HYDROGEN STORAGE VESSEL
SIZE : 2800 mm (ID) X 15500 mm (L T/T)
DESIGN P/T : 40 barg / -10 / 80 °C
MATERIAL : CARBON STEEL
OPERATING P/T : 30 barg / AMB
V-25001E
TRIM LINE: 3"-HY-178-03HSS-N
TYPE 6 CRITICAL
3
2
1
4
7
9
NOTES
1. NECESSARY CONTROL SYSTEM SOFTWARE SHALL BE INCLUDED TO SUPPORT ADVACED VALVE CONTROL, PARTIAL STROKE TESTING AND DIAGNOSTICS FOR ENY SAFETY CRITICAL ON/OFF VALVES. THESE APPLICATION SHALL BE IDENTIFIED BY HAZOP AND LAPA EVALUATION IF PARTIAL STROKE TESTING WILL BE REQUIRED:
THE "TYP. 3" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 2" FOR SDV
THE "TYP. 5" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 4" FOR BDV
2. TIGHT SHUT OFF VALVE.
3. VARIABLE AREA FLOWMETER TO BE INSTALLED VERTICALLY WITH DIRECTION OF FLOW UPWARDS.
4. NITROGEN CONTROL VALVE (25-FV-001), CAN NOT OPEN UNTIL THE PRESSURE WITHIN THE VESSEL IS BELOW THE NITROGEN SUPPLY PRESSURE.
5. ONE COMMON UNINSTALLED SPARE PSV FOR ALL VESSELS.
6. FOR PULSE PRESSURE PURGING OF VESSEL WITH HYDROGEN.
7. FOR FLOW PURGING OF VESSEL WITH NITROGEN.
HOLDS
1. SIZE OF LINES UPSTREAM AND DOWNSTREAM PSV AND ORIFICE ARE IN HOLD.
2. PSV SIZE (BY VENDOR).
3. CONTROL VALVE SIZE (BY VENDOR).
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE : BLPH PIPING AND INSTRUMENTATION DIAGRAM HYDROGEN STORAGE VESSEL E
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN CHECKED APPROVED DATE
A1
DRAWING NO. 123A90-DDL-PR-PID-80019
SHEET 001
REV. 00
File Name : FILE_NAME
DRAWING_NO.
REV.



NOTES

1. NECESSARY CONTROL SYSTEM SOFTWARE SHALL BE INCLUDED TO SUPPORT ADVACED VALVE CONTROL, PARTIAL STROKE TESTING AND DIAGNOSTICS FOR ENY SAFETY CRITICAL ON/OFF VALVES. THESE APPLICATION SHALL BE IDENTIFIED BY HAZOP AND LAPA EVALUATION IF PARTIAL STROKE TESTING WILL BE REQUIRED:
   THE "TYP. 3" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 2" FOR SDV
   THE "TYP. 5" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 4" FOR BDV
2. TIGHT SHUT OFF VALVE.
3. VARIABLE AREA FLOWMETER TO BE INSTALLED VERTICALLY WITH DIRECTION OF FLOW UPWARDS.
4. NITROGEN CONTROL VALVE (25-FV-001), CAN NOT OPEN UNTIL THE PRESSURE WITHIN THE VESSEL IS BELOW THE NITROGEN SUPPLY PRESSURE.
5. ONE COMMON UNINSTALLED SPARE PSV FOR ALL VESSELS.
6. FOR PULSE PRESSURE PURGING OF VESSEL WITH HYDROGEN.
7. FOR FLOW PURGING OF VESSEL WITH NITROGEN.

HOLDS

1. SIZE OF LINES UPSTREAM AND DOWNSTREAM PSV AND ORIFICE ARE IN HOLD.
2. PSV SIZE (BY VENDOR).
3. CONTROL VALVE SIZE (BY VENDOR).

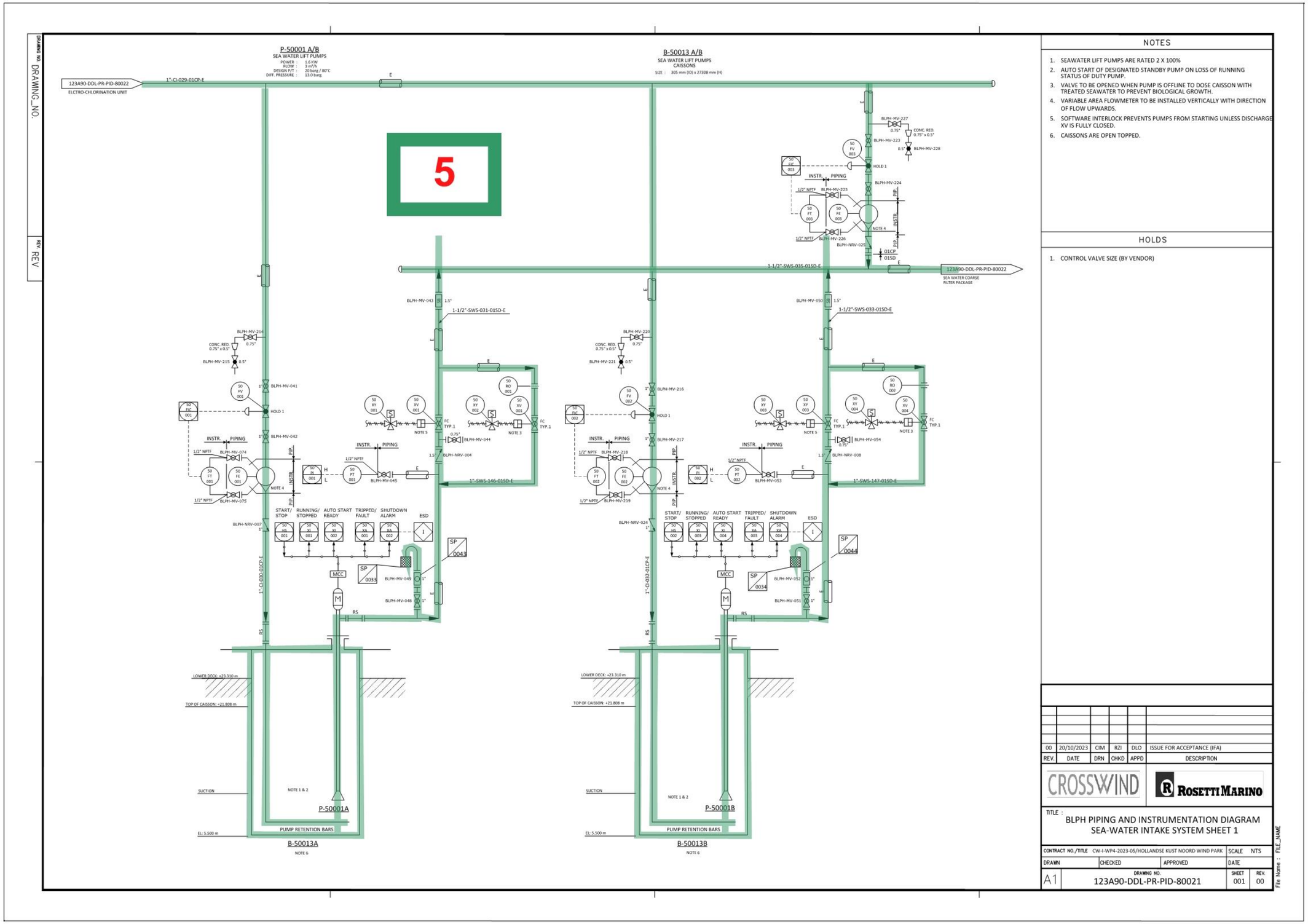
REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
00	20/10/2023	CIM	RZI	DLO	ISSUE FOR ACCEPTANCE (IFA)

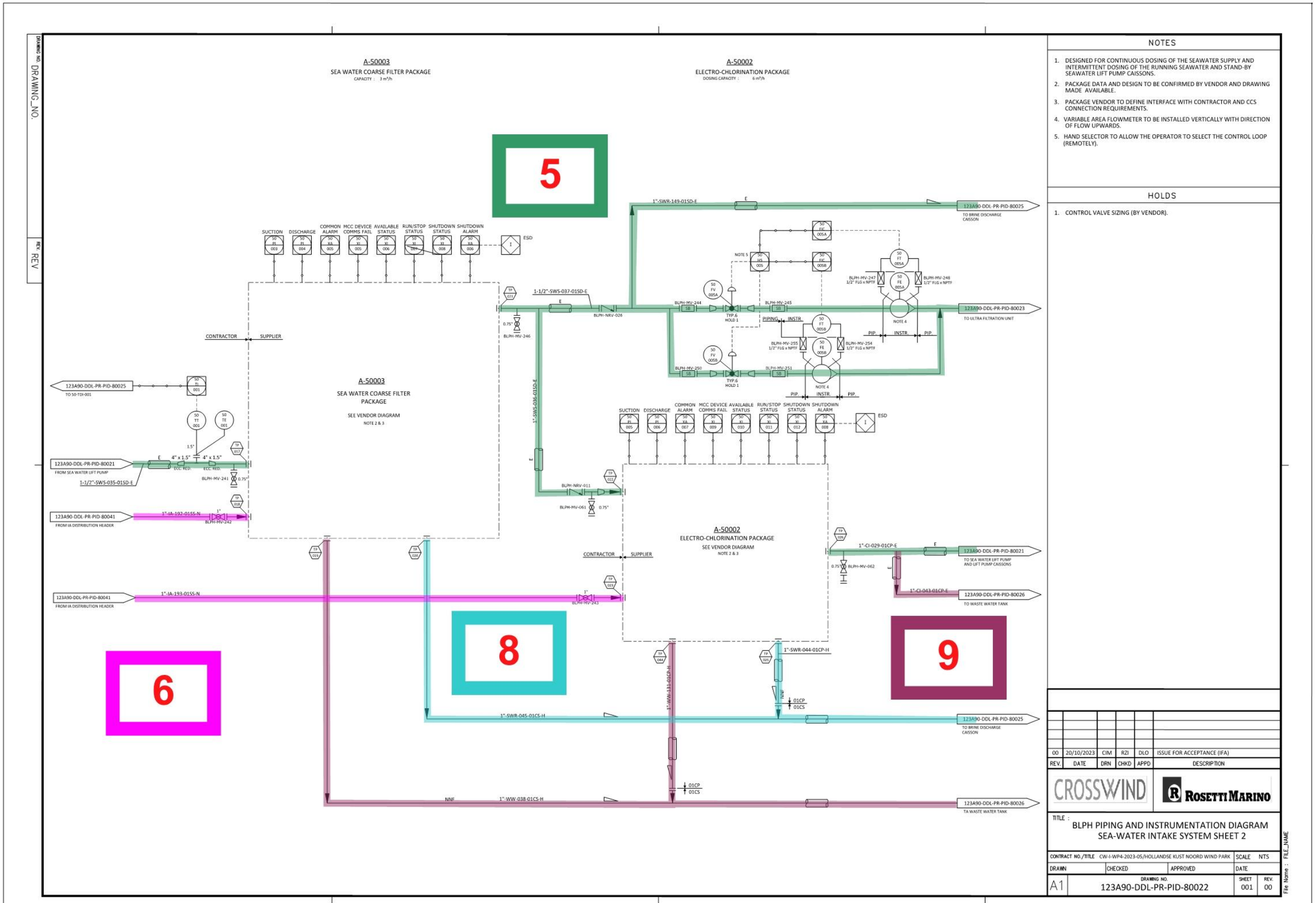
CROSSWIND — ROSETTI MARINO

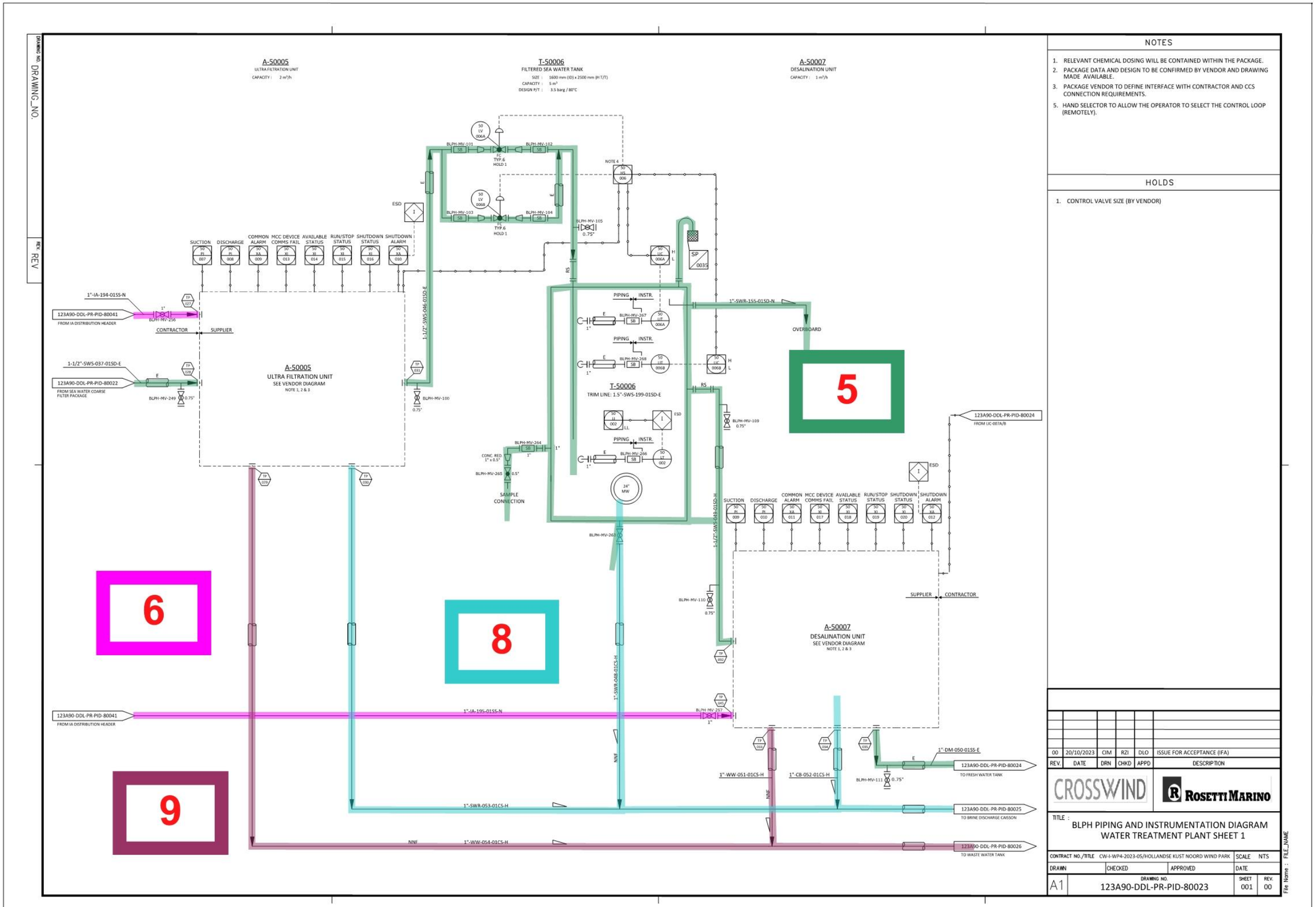
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
HYDROGEN STORAGE VESSEL F

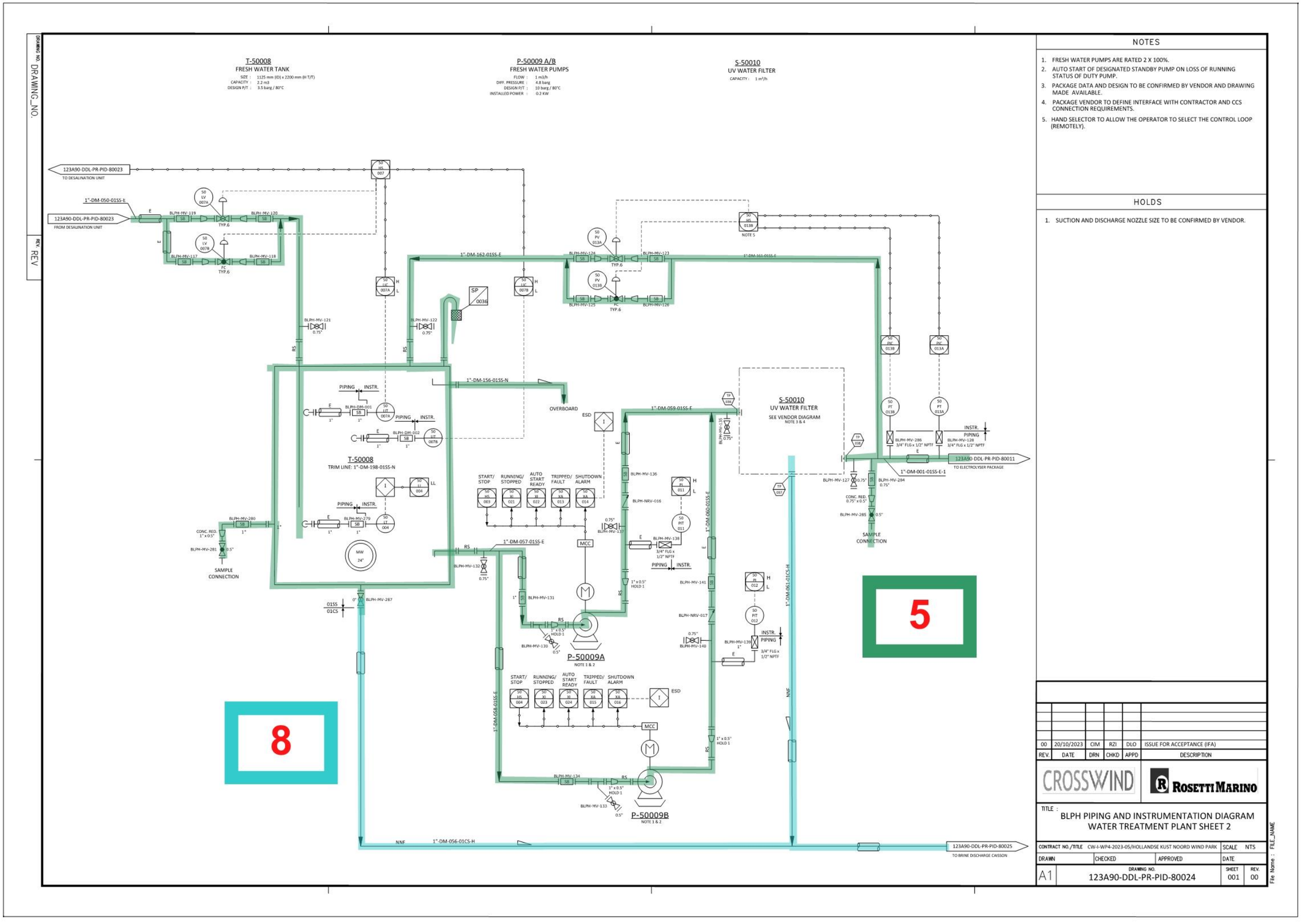
CONTRACT NO./TITLE	CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK		SCALE NTS
DRAWN	CHECKED	APPROVED	DATE
A1	DRAWING NO. 123A90-DDL-PR-PID-80020	SHEET 001	REV. 00

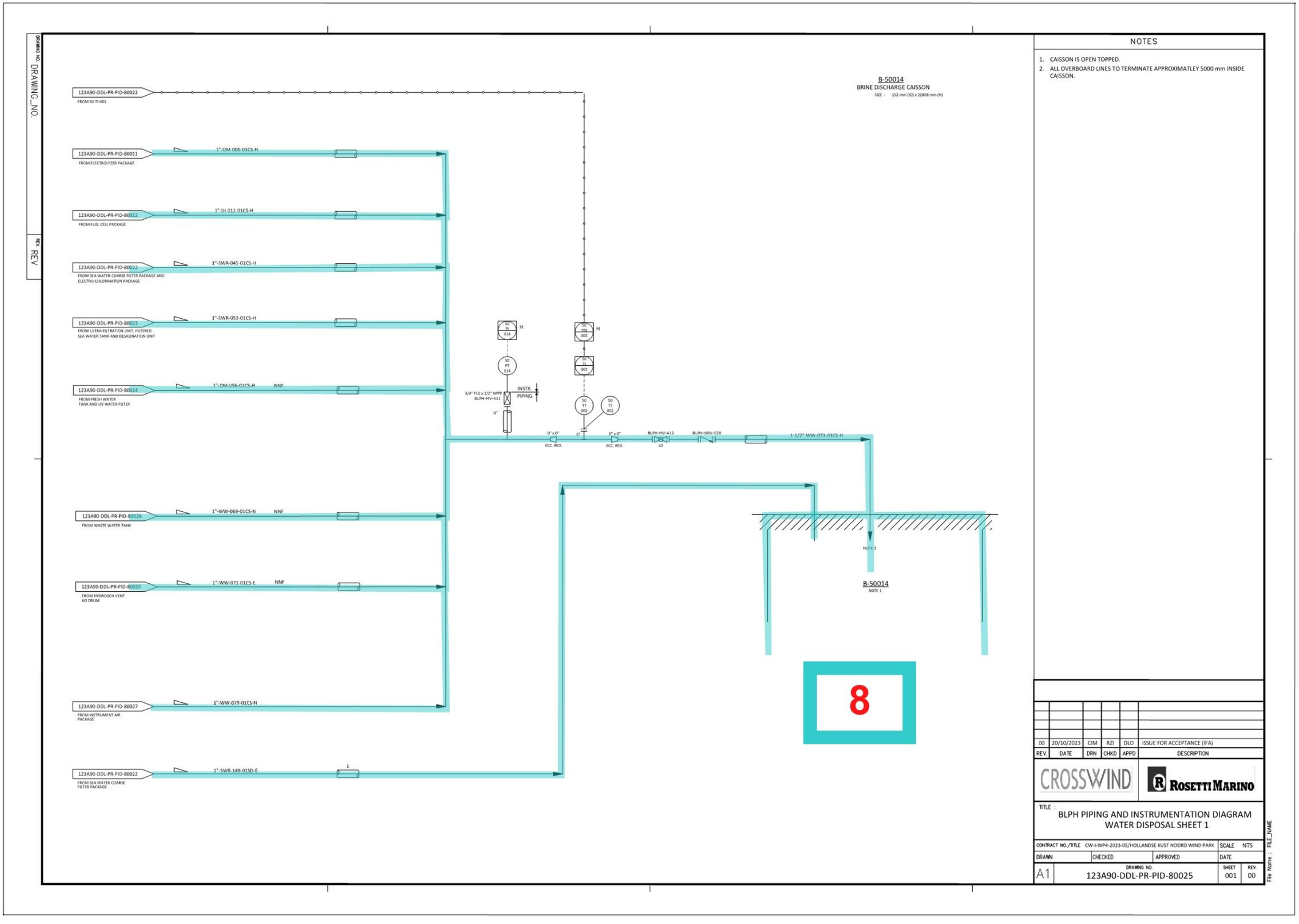
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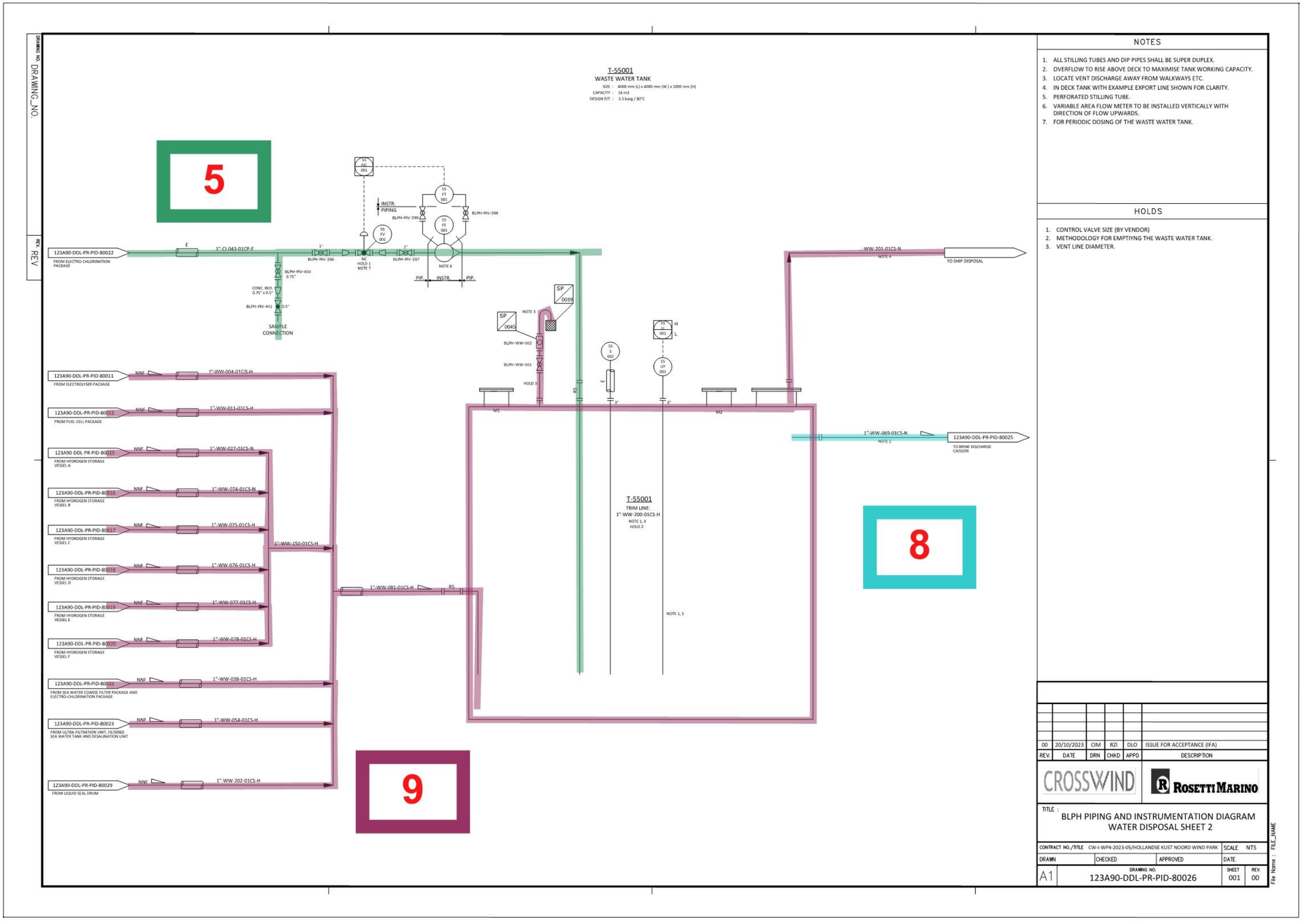

P-50001 A/B
SEA WATER LIFT PUMPS
POWER : 1.6 KW
FLOW : 3 m³/h
DESIGN P/T : 20 barg / 80°C
DIFF. PRESSURE : 13.0 barg
B-50013 A/B
SEA WATER LIFT PUMPS CAISSONS
SIZE : 305 mm (ID) x 27308 mm (H)
123A90-DDL-PR-PID-80022
ELCTRO-CHLORINATION UNIT
1"-CI-029-01CP-E
5
BLPH-MV-227
BLPH-MV-223
BLPH-MV-228
BLPH-MV-224
BLPH-MV-225
BLPH-MV-226
BLPH-NRV-025
01CP
01SD
1-1/2"-SWS-035-01SD-E
123A90-DDL-PR-PID-80022
SEA WATER COARSE FILTER PACKAGE
BLPH-MV-043
1-1/2"-SWS-031-01SD-E
BLPH-MV-050
1-1/2"-SWS-033-01SD-E
BLPH-MV-214
BLPH-MV-215
BLPH-MV-220
BLPH-MV-221
BLPH-MV-041
BLPH-MV-042
BLPH-MV-216
BLPH-MV-217
BLPH-MV-044
BLPH-NRV-004
BLPH-MV-045
BLPH-MV-054
BLPH-NRV-008
BLPH-MV-053
1"-SWS-146-01SD-E
1"-SWS-147-01SD-E
BLPH-MV-074
BLPH-MV-075
BLPH-MV-218
BLPH-MV-219
BLPH-NRV-007
BLPH-NRV-024
1"-CI-030-01CP-E
1"-CI-032-01CP-E
START/ STOP
RUNNING/ STOPPED
AUTO START READY
TRIPPED/ FAULT
SHUTDOWN ALARM
ESD
SP 0043
SP 0033
SP 0044
SP 0034
BLPH-MV-049
BLPH-MV-048
BLPH-MV-052
BLPH-MV-051
MCC
RS
LOWER DECK: +23.310 m
TOP OF CAISSON: +21.808 m
SUCTION
NOTE 1 & 2
P-50001A
P-50001B
PUMP RETENTION BARS
EL: 5.500 m
B-50013A
B-50013B
NOTE 6
NOTES
1. SEAWATER LIFT PUMPS ARE RATED 2 X 100%
2. AUTO START OF DESIGNATED STANDBY PUMP ON LOSS OF RUNNING STATUS OF DUTY PUMP.
3. VALVE TO BE OPENED WHEN PUMP IS OFFLINE TO DOSE CAISSON WITH TREATED SEAWATER TO PREVENT BIOLOGICAL GROWTH.
4. VARIABLE AREA FLOWMETER TO BE INSTALLED VERTICALLY WITH DIRECTION OF FLOW UPWARDS.
5. SOFTWARE INTERLOCK PREVENTS PUMPS FROM STARTING UNLESS DISCHARGE XV IS FULLY CLOSED.
6. CAISSONS ARE OPEN TOPPED.
HOLDS
1. CONTROL VALVE SIZE (BY VENDOR)
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE : BLPH PIPING AND INSTRUMENTATION DIAGRAM SEA-WATER INTAKE SYSTEM SHEET 1
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN CHECKED APPROVED DATE
A1
DRAWING NO. 123A90-DDL-PR-PID-80021
SHEET 001
REV. 00
DRAWING NO. DRAWING_NO.
REV. REV
File Name : FILE_NAME

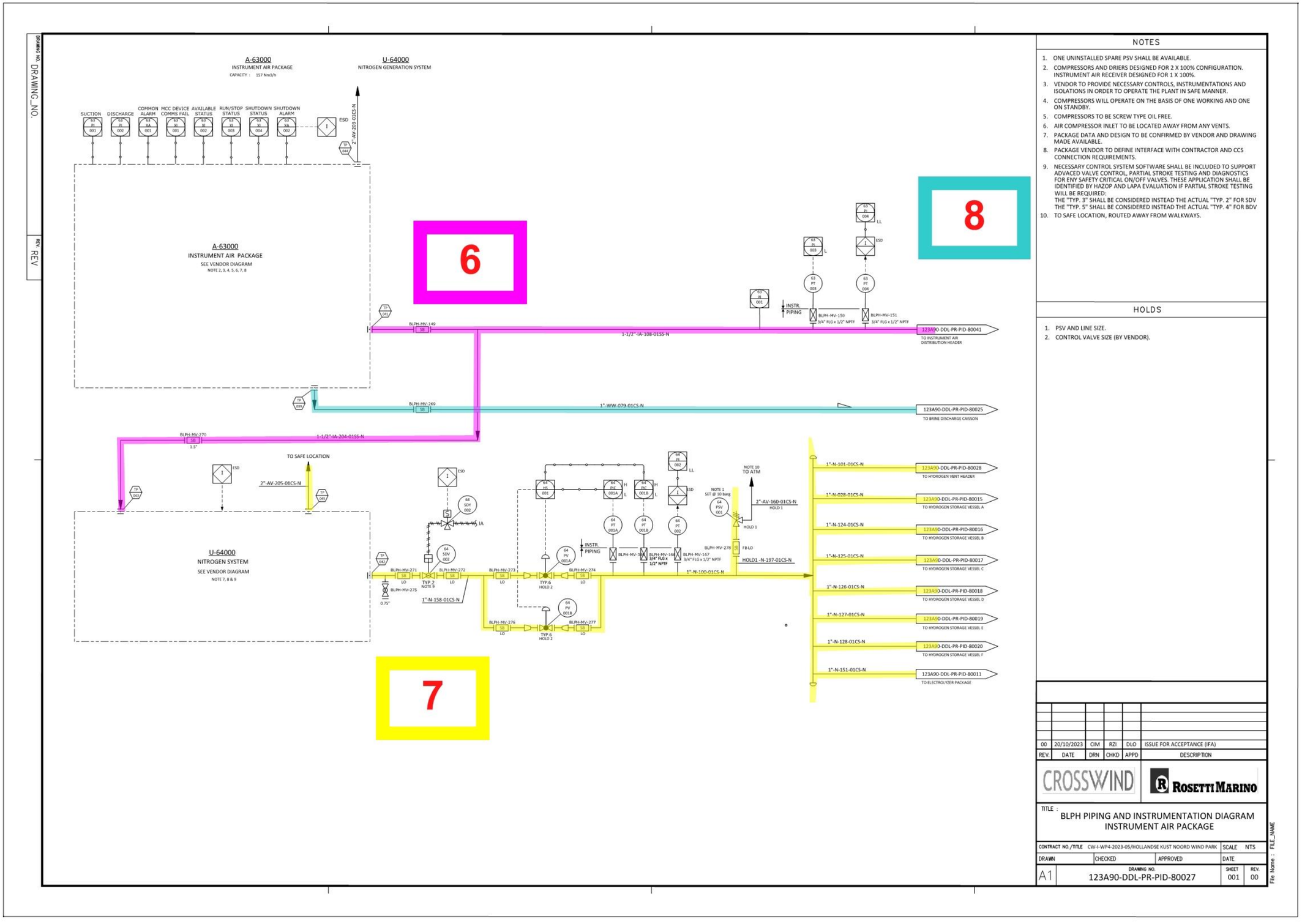

DRAWING_NO.
REV.
A-50003
SEA WATER COARSE FILTER PACKAGE
CAPACITY : 3 m³/h
A-50002
ELECTRO-CHLORINATION PACKAGE
DOSING CAPACITY : 6 m³/h
5
SUCTION
DISCHARGE
COMMON ALARM
MCC DEVICE COMMS FAIL
AVAILABLE STATUS
RUN/STOP STATUS
SHUTDOWN STATUS
SHUTDOWN ALARM
ESD
1"-SWR-149-01SD-E
123A90-DDL-PR-PID-80075
TO BRINE DISCHARGE CAISSON
1-1/2"-SWS-037-01SD-E
BLPH-NRV-026
BLPH-MV-244
BLPH-MV-245
BLPH-MV-247
BLPH-MV-248
BLPH-MV-255
BLPH-MV-254
BLPH-MV-250
BLPH-MV-251
TYP.6 HOLD 1
NOTE 4
NOTE 5
PIPING
INSTR.
PIP
123A90-DDL-PR-PID-80023
TO ULTRA FILTRATION UNIT
CONTRACTOR
SUPPLIER
A-50003
SEA WATER COARSE FILTER PACKAGE
SEE VENDOR DIAGRAM
NOTE 2 & 3
123A90-DDL-PR-PID-80025
TO 50-TDI-001
1.5"
4" x 1.5"
ECC. RED.
123A90-DDL-PR-PID-80021
FROM SEA WATER LIFT PUMP
1-1/2"-SWS-035-01SD-E
BLPH-MV-241
123A90-DDL-PR-PID-80041
FROM IA DISTRIBUTION HEADER
1"-IA-192-01SS-N
BLPH-MV-242
1"-IA-193-01SS-N
BLPH-MV-243
1"-SWS-036-01SD-E
BLPH-NRV-011
BLPH-MV-061
0.75"
A-50002
ELECTRO-CHLORINATION PACKAGE
SEE VENDOR DIAGRAM
NOTE 2 & 3
1"-CI-029-01CP-E
BLPH-MV-062
123A90-DDL-PR-PID-80021
TO SEA WATER LIFT PUMP AND LIFT PUMP CAISSONS
1"-CI-043-01CP-E
123A90-DDL-PR-PID-80026
TO WASTE WATER TANK
6
8
9
1"-SWR-044-01CP-H
1"-WW-131-01CP-H
1"-SWR-045-01CS-H
01CP
01CS
NNF
1"-WW-038-01CS-H
123A90-DDL-PR-PID-80025
TO BRINE DISCHARGE CAISSON
123A90-DDL-PR-PID-80026
TA WASTE WATER TANK
NOTES
1. DESIGNED FOR CONTINUOUS DOSING OF THE SEAWATER SUPPLY AND INTERMITTENT DOSING OF THE RUNNING SEAWATER AND STAND-BY SEAWATER LIFT PUMP CAISSONS.
2. PACKAGE DATA AND DESIGN TO BE CONFIRMED BY VENDOR AND DRAWING MADE AVAILABLE.
3. PACKAGE VENDOR TO DEFINE INTERFACE WITH CONTRACTOR AND CCS CONNECTION REQUIREMENTS.
4. VARIABLE AREA FLOWMETER TO BE INSTALLED VERTICALLY WITH DIRECTION OF FLOW UPWARDS.
5. HAND SELECTOR TO ALLOW THE OPERATOR TO SELECT THE CONTROL LOOP (REMOTELY).
HOLDS
1. CONTROL VALVE SIZING (BY VENDOR).
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
SEA-WATER INTAKE SYSTEM SHEET 2
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN CHECKED APPROVED DATE
A1
DRAWING NO. 123A90-DDL-PR-PID-80022
SHEET 001
REV. 00
File Name : FILE_NAME

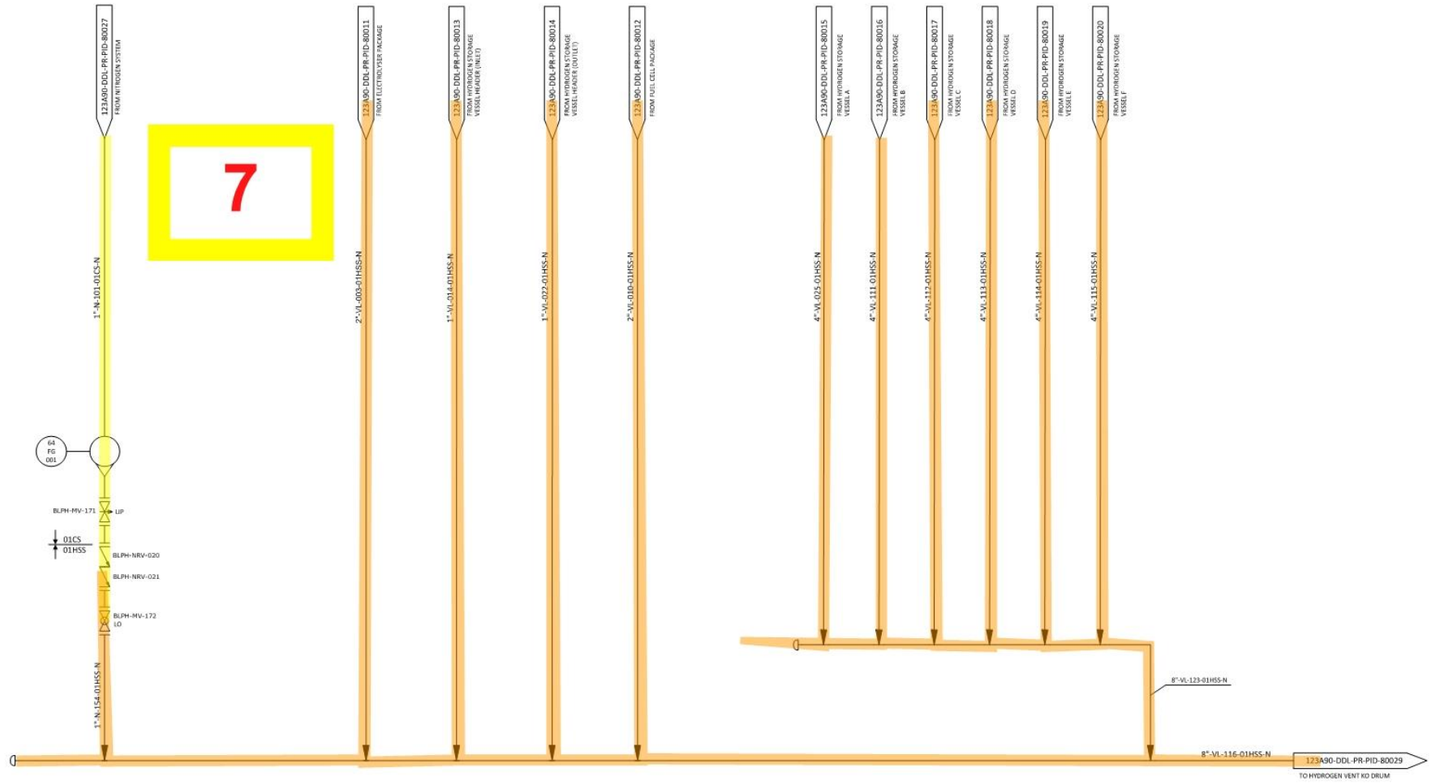

DRAWING_NO.
REV.
A-50005
ULTRA FILTRATION UNIT
CAPACITY : 2 m³/h
T-50006
FILTERED SEA WATER TANK
SIZE : 1600 mm (ID) x 2500 mm (H T/T)
CAPACITY : 5 m³
DESIGN P/T : 3.5 barg / 80°C
A-50007
DESALINATION UNIT
CAPACITY : 1 m³/h
BLPH-MV-101
BLPH-MV-102
BLPH-MV-103
BLPH-MV-104
BLPH-MV-105
0.75"
TYP.6
HOLD 1
NOTE 4
ESD
SUCTION
DISCHARGE
COMMON ALARM
MCC DEVICE COMMS FAIL
AVAILABLE STATUS
RUN/STOP STATUS
SHUTDOWN STATUS
SHUTDOWN ALARM
1"-IA-194-01SS-N
123A90-DDL-PR-PID-80041
FROM IA DISTRIBUTION HEADER
CONTRACTOR
SUPPLIER
1-1/2"-SWS-037-01SD-E
123A90-DDL-PR-PID-80022
FROM SEA WATER COARSE FILTER PACKAGE
BLPH-MV-249
A-50005
ULTRA FILTRATION UNIT
SEE VENDOR DIAGRAM
NOTE 1, 2 & 3
1-1/2"-SWS-096-01SD-E
BLPH-MV-100
PIPING INSTR.
BLPH-MV-267
BLPH-MV-268
1"-SWR-15S-01SD-N
OVERBOARD
T-50006
TRIM LINE: 1.5"-SWS-199-01SD-E
BLPH-MV-109
BLPH-MV-264
BLPH-MV-265
BLPH-MV-266
CONC. RED 1" x 0.5"
SAMPLE CONNECTION
24" MW
BLPH-MV-269
1-1/2"-SWS-048-01SD-H
123A90-DDL-PR-PID-80024
FROM LIC-007A/B
BLPH-MV-110
A-50007
DESALINATION UNIT
SEE VENDOR DIAGRAM
NOTE 1, 2 & 3
1"-SWR-048-01CS-H
1"-IA-195-01SS-N
BLPH-MV-257
1"-DM-050-01SS-E
BLPH-MV-111
123A90-DDL-PR-PID-80024
TO FRESH WATER TANK
1"-WW-051-01CS-H
1"-CB-052-01CS-H
1"-SWR-053-01CS-H
123A90-DDL-PR-PID-80025
TO BRINE DISCHARGE CAISSON
1"-WW-054-01CS-H
123A90-DDL-PR-PID-80026
TO WASTE WATER TANK
NNF
5
6
8
9
NOTES
1. RELEVANT CHEMICAL DOSING WILL BE CONTAINED WITHIN THE PACKAGE.
2. PACKAGE DATA AND DESIGN TO BE CONFIRMED BY VENDOR AND DRAWING MADE AVAILABLE.
3. PACKAGE VENDOR TO DEFINE INTERFACE WITH CONTRACTOR AND CCS CONNECTION REQUIREMENTS.
5. HAND SELECTOR TO ALLOW THE OPERATOR TO SELECT THE CONTROL LOOP (REMOTELY).
HOLDS
1. CONTROL VALVE SIZE (BY VENDOR)
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
WATER TREATMENT PLANT SHEET 1
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN CHECKED APPROVED DATE
A1
DRAWING NO. 123A90-DDL-PR-PID-80023
SHEET 001
REV. 00
File Name : FILE_NAME

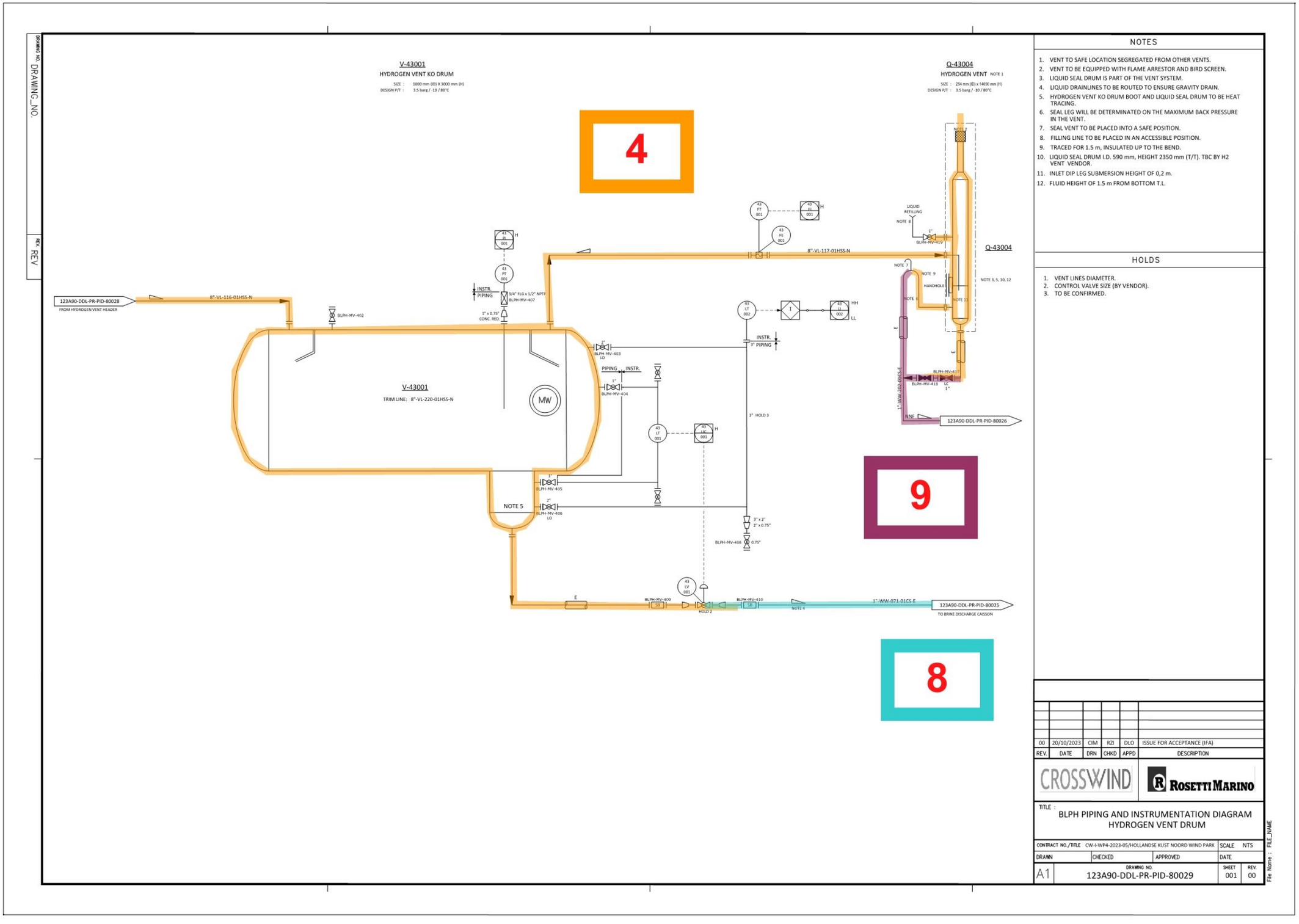

T-50008
FRESH WATER TANK
SIZE : 1125 mm (ID) x 2200 mm (H T/T)
CAPACITY : 2.2 m3
DESIGN P/T : 3.5 barg / 80°C
P-50009 A/B
FRESH WATER PUMPS
FLOW : 1 m3/h
DIFF. PRESSURE : 4.8 barg
DESIGN P/T : 10 barg / 80°C
INSTALLED POWER : 0.2 KW
S-50010
UV WATER FILTER
CAPACITY : 1 m³/h
NOTES
1. FRESH WATER PUMPS ARE RATED 2 X 100%.
2. AUTO START OF DESIGNATED STANDBY PUMP ON LOSS OF RUNNING STATUS OF DUTY PUMP.
3. PACKAGE DATA AND DESIGN TO BE CONFIRMED BY VENDOR AND DRAWING MADE AVAILABLE.
4. PACKAGE VENDOR TO DEFINE INTERFACE WITH CONTRACTOR AND CCS CONNECTION REQUIREMENTS.
5. HAND SELECTOR TO ALLOW THE OPERATOR TO SELECT THE CONTROL LOOP (REMOTELY).
HOLDS
1. SUCTION AND DISCHARGE NOZZLE SIZE TO BE CONFIRMED BY VENDOR.
123A90-DDL-PR-PID-80023
TO DESALINATION UNIT
123A90-DDL-PR-PID-80023
FROM DESALINATION UNIT
1"-DM-050-01SS-E
BLPH-MV-119
BLPH-MV-120
BLPH-MV-117
BLPH-MV-118
1"-DM-162-01SS-E
1"-DM-161-01SS-E
BLPH-MV-124
BLPH-MV-123
BLPH-MV-125
BLPH-MV-126
NOTE 5
BLPH-MV-121
BLPH-MV-122
1"-DM-156-01SS-N
OVERBOARD
ESD
1"-DM-059-01SS-E
S-50010
UV WATER FILTER
SEE VENDOR DIAGRAM
NOTE 3 & 4
BLPH-MV-286
3/4" FLG x 1/2" NPTF
BLPH-MV-128
3/4" FLG x 1/2" NPTF
123A90-DDL-PR-PID-80011
TO ELECTROLYSER PACKAGE
1"-DM-001-01SS-E-1
BLPH-MV-127
BLPH-MV-284
BLPH-MV-285
SAMPLE CONNECTION
T-50008
TRIM LINE: 1"-DM-198-01SS-N
PIPING
INSTR.
BLPH-DM-001
BLPH-DM-002
BLPH-MV-279
BLPH-MV-280
BLPH-MV-281
START/ STOP
RUNNING/ STOPPED
AUTO START READY
TRIPPED/ FAULT
SHUTDOWN ALARM
BLPH-MV-136
BLPH-NRV-016
BLPH-MV-137
BLPH-MV-138
1"-DM-060-01SS-E
1"-DM-057-01SS-E
BLPH-MV-132
BLPH-MV-131
BLPH-MV-141
BLPH-NRV-017
BLPH-MV-140
BLPH-MV-139
1"-DM-061-01CS-H
MCC
P-50009A
NOTE 1 & 2
P-50009B
NOTE 1 & 2
BLPH-MV-130
BLPH-MV-134
BLPH-MV-133
1"-DM-058-01SS-E
01SS
01CS
BLPH-MV-287
NNF
1"-DM-056-01CS-H
123A90-DDL-PR-PID-80025
TO BRINE DISCHARGE CAISSON
5
8
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
WATER TREATMENT PLANT SHEET 2
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN CHECKED APPROVED DATE
A1
DRAWING NO. 123A90-DDL-PR-PID-80024
SHEET 001
REV. 00
DRAWING NO.
REV.
File Name : FILE_NAME

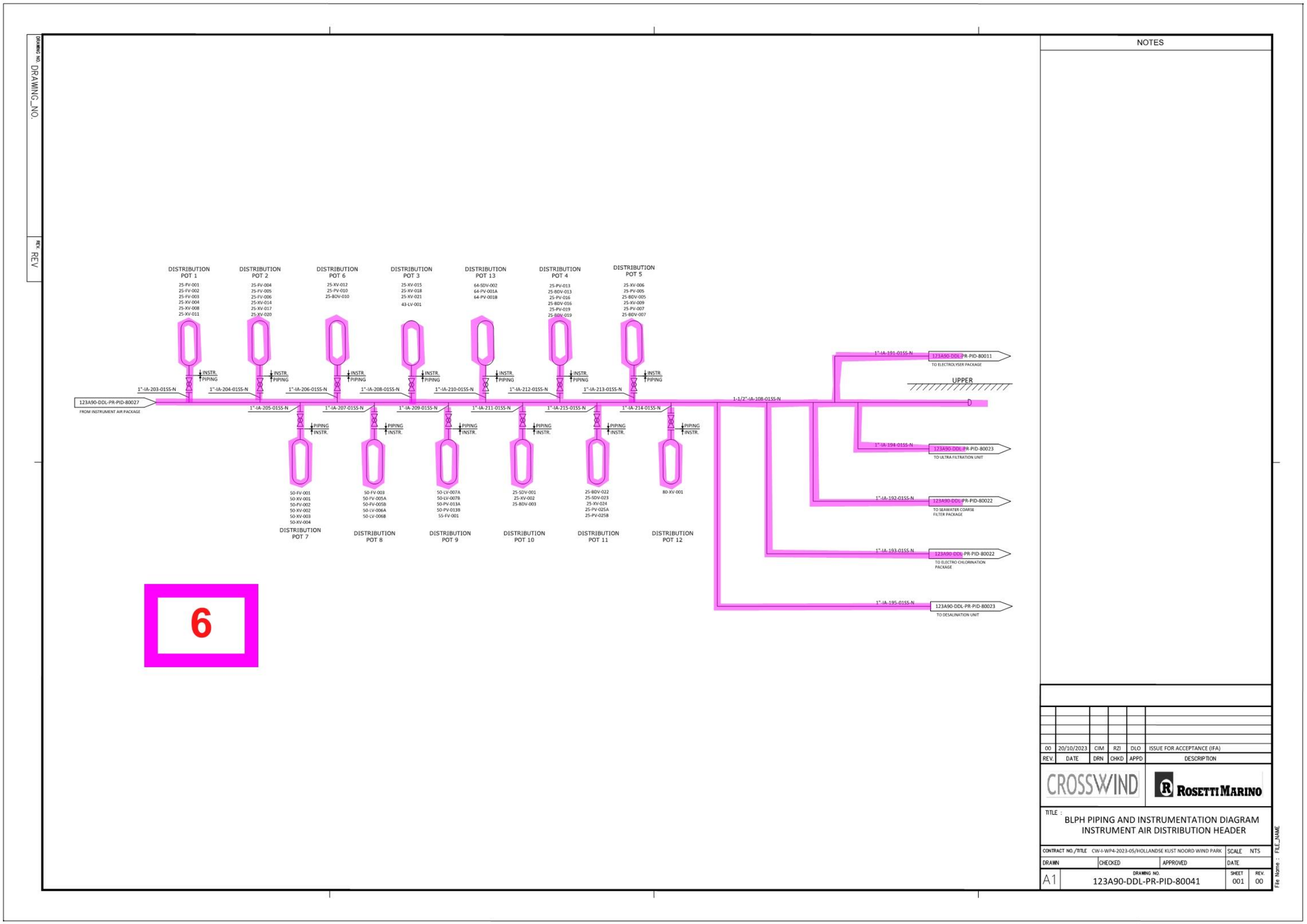

DRAWING_NO.
REV.
123A90-DDL-PR-PID-80022
FROM S0-TI-001
123A90-DDL-PR-PID-80011
FROM ELECTROLYZER PACKAGE
1"-DM-005-01CS-H
123A90-DDL-PR-PID-80012
FROM FUEL CELL PACKAGE
1"-DI-012-01CS-H
123A90-DDL-PR-PID-80022
FROM SEA WATER COARSE FILTER PACKAGE AND ELECTRO-CHLORINATION PACKAGE
1"-SWR-045-01CS-H
123A90-DDL-PR-PID-80023
FROM ULTRA-FILTRATION UNIT, FILTERED SEA WATER TANK AND DESALINATION UNIT
1"-SWR-053-01CS-H
123A90-DDL-PR-PID-80024
FROM FRESH WATER TANK AND UV WATER FILTER
1"-DM-056-01CS-H
NNF
123A90-DDL-PR-PID-80026
FROM WASTE WATER TANK
1"-WW-069-01CS-N
NNF
123A90-DDL-PR-PID-80029
FROM HYDROGEN VENT KO DRUM
1"-WW-071-01CS-E
NNF
123A90-DDL-PR-PID-80027
FROM INSTRUMENT AIR PACKAGE
1"-WW-079-01CS-N
123A90-DDL-PR-PID-80022
FROM SEA WATER COARSE FILTER PACKAGE
1"-SWR-149-01SD-E
E
B-50014
BRINE DISCHARGE CAISSON
SIZE : 152 mm (ID) x 21808 mm (H)
50 PI 014
50 PT 014
50 TI 002
50 TT 002
50 TE 002
H
INSTR. PIPING
3/4" FLG x 1/2" NPTF
BLPH-HV-411
0" x 0"
ECC. RED.
BLPH-HV-412
LO
BLPH-NRV-028
1-1/2"-WW-073-01CS-H
NOTE 2
B-50014
NOTE 1
8
NOTES
1. CAISSON IS OPEN TOPPED.
2. ALL OVERBOARD LINES TO TERMINATE APPROXIMATLEY 5000 mm INSIDE CAISSON.
00 | 20/10/2023 | CIM | RZI | DLO | ISSUE FOR ACCEPTANCE (IFA)
REV. | DATE | DRN | CHKD | APPD | DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
WATER DISPOSAL SHEET 1
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN | CHECKED | APPROVED | DATE
A1
DRAWING NO. 123A90-DDL-PR-PID-80025
SHEET 001
REV. 00
File Name : FILE_NAME


DRAWING_NO.
REV.
5
T-55001
WASTE WATER TANK
SIZE : 4000 mm (L) x 4000 mm (W) x 1000 mm (H)
CAPACITY : 16 m3
DESIGN P/T : 3.5 barg / 80°C
123A90-DDL-PR-PID-80022
FROM ELECTRO-CHLORINATION PACKAGE
SAMPLE CONNECTION
INSTR. PIPING
BLPH-MV-396
BLPH-MV-397
BLPH-MV-398
BLPH-MV-399
BLPH-MV-400
BLPH-MV-401
123A90-DDL-PR-PID-80011
FROM ELECTROLYSER PACKAGE
123A90-DDL-PR-PID-80012
FROM FUEL CELL PACKAGE
123A90-DDL-PR-PID-80015
FROM HYDROGEN STORAGE VESSEL A
123A90-DDL-PR-PID-80016
FROM HYDROGEN STORAGE VESSEL B
123A90-DDL-PR-PID-80017
FROM HYDROGEN STORAGE VESSEL C
123A90-DDL-PR-PID-80018
FROM HYDROGEN STORAGE VESSEL D
123A90-DDL-PR-PID-80019
FROM HYDROGEN STORAGE VESSEL E
123A90-DDL-PR-PID-80020
FROM HYDROGEN STORAGE VESSEL F
123A90-DDL-PR-PID-80022
FROM SEA WATER COARSE FILTER PACKAGE AND ELECTRO-CHLORINATION PACKAGE
123A90-DDL-PR-PID-80023
FROM ULTRA-FILTRATION UNIT, FILTERED SEA WATER TANK AND DESALINATION UNIT
123A90-DDL-PR-PID-80029
FROM LIQUID SEAL DRUM
1"-WW-004-01CS-H
1"-WW-011-01CS-H
1"-WW-027-01CS-N
1"-WW-074-01CS-N
1"-WW-075-01CS-H
1"-WW-076-01CS-H
1"-WW-077-01CS-H
1"-WW-078-01CS-H
1"-WW-038-01CS-H
1"-WW-054-01CS-H
1"-WW-202-01CS-H
1"-WW-150-01CS-H
1"-WW-081-01CS-H
1"-WW-201-01CS-N
TO SHIP DISPOSAL
1"-WW-069-01CS-N
123A90-DDL-PR-PID-80025
TO BRINE DISCHARGE CAISSON
T-55001
TRIM LINE:
1"-WW-200-01CS-H
8
9
NOTES
1. ALL STILLING TUBES AND DIP PIPES SHALL BE SUPER DUPLEX.
2. OVERFLOW TO RISE ABOVE DECK TO MAXIMISE TANK WORKING CAPACITY.
3. LOCATE VENT DISCHARGE AWAY FROM WALKWAYS ETC.
4. IN DECK TANK WITH EXAMPLE EXPORT LINE SHOWN FOR CLARITY.
5. PERFORATED STILLING TUBE.
6. VARIABLE AREA FLOW METER TO BE INSTALLED VERTICALLY WITH DIRECTION OF FLOW UPWARDS.
7. FOR PERIODIC DOSING OF THE WASTE WATER TANK.
HOLDS
1. CONTROL VALVE SIZE (BY VENDOR)
2. METHODOLOGY FOR EMPTIYNG THE WASTE WATER TANK.
3. VENT LINE DIAMETER.
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
WATER DISPOSAL SHEET 2
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN CHECKED APPROVED DATE
A1
DRAWING NO. 123A90-DDL-PR-PID-80026
SHEET 001
REV. 00
File Name : FILE_NAME


A-63000
INSTRUMENT AIR PACKAGE
CAPACITY : 157 Nm3/h
U-64000
NITROGEN GENERATION SYSTEM
SUCTION
DISCHARGE
COMMON ALARM
MCC DEVICE COMMS FAIL
AVAILABLE STATUS
RUN/STOP STATUS
SHUTDOWN STATUS
SHUTDOWN ALARM
ESD
2"-AV-205-01CS-N
A-63000
INSTRUMENT AIR PACKAGE
SEE VENDOR DIAGRAM
NOTE 2, 3, 4, 5, 6, 7, 8
6
8
BLPH-MV-149
1-1/2"-IA-108-01SS-N
INSTR. PIPING
BLPH-MV-150
3/4" FLG x 1/2" NPTF
BLPH-MV-151
3/4" FLG x 1/2" NPTF
123A90-DDL-PR-PID-80041
TO INSTRUMENT AIR DISTRIBUTION HEADER
BLPH-MV-269
1"-WW-079-01CS-N
123A90-DDL-PR-PID-80025
TO BRINE DISCHARGE CAISSON
BLPH-MV-270
1-1/2"-IA-204-01SS-N
TO SAFE LOCATION
2"-AV-205-01CS-N
U-64000
NITROGEN SYSTEM
SEE VENDOR DIAGRAM
NOTE 7, 8 & 9
BLPH-MV-271
BLPH-MV-272
BLPH-MV-273
BLPH-MV-274
BLPH-MV-275
1"-N-158-01CS-N
BLPH-MV-276
BLPH-MV-277
TYP 2 NOTE 9
TYP 6 HOLD 2
INSTR. PIPING
BLPH-MV-166
3/4" FLG x 1/2" NPTF
BLPH-MV-167
3/4" FLG x 1/2" NPTF
1"-N-100-01CS-N
NOTE 10
TO ATM
NOTE 1
SET @ 10 barg
2"-AV-160-01CS-N
HOLD 1
BLPH-MV-278
FB-LO
HOLD1-N-197-01CS-N
1"-N-101-01CS-N
123A90-DDL-PR-PID-80028
TO HYDROGEN VENT HEADER
1"-N-028-01CS-N
123A90-DDL-PR-PID-80015
TO HYDROGEN STORAGE VESSEL A
1"-N-124-01CS-N
123A90-DDL-PR-PID-80016
TO HYDROGEN STORAGE VESSEL B
1"-N-125-01CS-N
123A90-DDL-PR-PID-80017
TO HYDROGEN STORAGE VESSEL C
1"-N-126-01CS-N
123A90-DDL-PR-PID-80018
TO HYDROGEN STORAGE VESSEL D
1"-N-127-01CS-N
123A90-DDL-PR-PID-80019
TO HYDROGEN STORAGE VESSEL E
1"-N-128-01CS-N
123A90-DDL-PR-PID-80020
TO HYDROGEN STORAGE VESSEL F
1"-N-151-01CS-N
123A90-DDL-PR-PID-80011
TO ELECTROLYZER PACKAGE
7
NOTES
1. ONE UNINSTALLED SPARE PSV SHALL BE AVAILABLE.
2. COMPRESSORS AND DRIERS DESIGNED FOR 2 X 100% CONFIGURATION. INSTRUMENT AIR RECEIVER DESIGNED FOR 1 X 100%.
3. VENDOR TO PROVIDE NECESSARY CONTROLS, INSTRUMENTATIONS AND ISOLATIONS IN ORDER TO OPERATE THE PLANT IN SAFE MANNER.
4. COMPRESSORS WILL OPERATE ON THE BASIS OF ONE WORKING AND ONE ON STANDBY.
5. COMPRESSORS TO BE SCREW TYPE OIL FREE.
6. AIR COMPRESSOR INLET TO BE LOCATED AWAY FROM ANY VENTS.
7. PACKAGE DATA AND DESIGN TO BE CONFIRMED BY VENDOR AND DRAWING MADE AVAILABLE.
8. PACKAGE VENDOR TO DEFINE INTERFACE WITH CONTRACTOR AND CCS CONNECTION REQUIREMENTS.
9. NECESSARY CONTROL SYSTEM SOFTWARE SHALL BE INCLUDED TO SUPPORT ADVACED VALVE CONTROL, PARTIAL STROKE TESTING AND DIAGNOSTICS FOR ENY SAFETY CRITICAL ON/OFF VALVES. THESE APPLICATION SHALL BE IDENTIFIED BY HAZOP AND LAPA EVALUATION IF PARTIAL STROKE TESTING WILL BE REQUIRED:
THE "TYP. 3" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 2" FOR SDV
THE "TYP. 5" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 4" FOR BDV
10. TO SAFE LOCATION, ROUTED AWAY FROM WALKWAYS.
HOLDS
1. PSV AND LINE SIZE.
2. CONTROL VALVE SIZE (BY VENDOR).
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
INSTRUMENT AIR PACKAGE
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN
CHECKED
APPROVED
DATE
A1
DRAWING NO. 123A90-DDL-PR-PID-80027
SHEET 001
REV. 00
DRAWING NO.
REV.
File Name : FILE_NAME

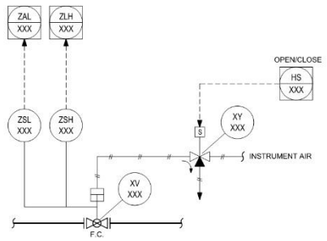

DRAWING_NO.
REV
7
1"-N-101-01CS-N
123A90-DDL-PR-PID-80027
FROM NITROGEN SYSTEM
2"-VL-003-01HSS-N
123A90-DDL-PR-PID-80011
FROM ELECTROLYSER PACKAGE
1"-VL-014-01HSS-N
123A90-DDL-PR-PID-80013
FROM HYDROGEN STORAGE VESSEL HEADER (INLET)
1"-VL-022-01HSS-N
123A90-DDL-PR-PID-80014
FROM HYDROGEN STORAGE VESSEL HEADER (OUTLET)
2"-VL-018-01HSS-N
123A90-DDL-PR-PID-80012
FROM FUEL CELL PACKAGE
4"-VL-025-01SSS-N
123A90-DDL-PR-PID-80015
FROM HYDROGEN STORAGE VESSEL A
4"-VL-111-01HSS-N
123A90-DDL-PR-PID-80016
FROM HYDROGEN STORAGE VESSEL B
4"-VL-112-01HSS-N
123A90-DDL-PR-PID-80017
FROM HYDROGEN STORAGE VESSEL C
4"-VL-113-01HSS-N
123A90-DDL-PR-PID-80018
FROM HYDROGEN STORAGE VESSEL D
4"-VL-114-01HSS-N
123A90-DDL-PR-PID-80019
FROM HYDROGEN STORAGE VESSEL E
4"-VL-115-01HSS-N
123A90-DDL-PR-PID-80020
FROM HYDROGEN STORAGE VESSEL F
8"-VL-123-01HSS-N
8"-VL-116-01HSS-N
123A90-DDL-PR-PID-80029
TO HYDROGEN VENT KO DRUM
BLPH-MV-171
LO
01CS
01HSS
BLPH-NRV-020
BLPH-NRV-021
BLPH-MV-172
LO
1"-N-154-01HSS-N
4
NOTES
HOLDS
1. VENT LINES DIAMETER.
00
20/10/2023
CIM
RZI
DLO
ISSUE FOR ACCEPTANCE (IFA)
REV.
DATE
DRN
CHKD
APPD
DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
HYDROGEN VENT HEADER
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN
CHECKED
APPROVED
DATE
A1
DRAWING NO.
123A90-DDL-PR-PID-80028
SHEET
001
REV.
00
File Name : FILE_NAME


DRAWING_NO.
REV.
V-43001
HYDROGEN VENT KO DRUM
SIZE : 1000 mm (ID) X 3000 mm (H)
DESIGN P/T : 3.5 barg / -10 / 80°C
Q-43004
HYDROGEN VENT NOTE 1
SIZE : 254 mm (ID) x 14690 mm (H)
DESIGN P/T : 3.5 barg / -10 / 80°C
4
9
8
123A90-DDL-PR-PID-80028
FROM HYDROGEN VENT HEADER
8"-VL-116-01HSS-N
BLPH-MV-402
INSTR. PIPING
3/4" FLG x 1/2" NPT
BLPH-MV-407
1" x 0.75" CONC. RED.
8"-VL-117-01HSS-N
LIQUID REFILLING
NOTE 8
BLPH-MV-419
NOTE 7
NOTE 9
HANDHOLE
NOTE 6
NOTE 11
NOTE 3, 5, 10, 12
BLPH-MV-417
BLPH-MV-418
1"-WW-202-01CS-E
NNF
123A90-DDL-PR-PID-80026
V-43001
TRIM LINE: 8"-VL-220-01HSS-N
MW
BLPH-MV-403
LO
PIPING
INSTR.
BLPH-MV-404
INSTR. 3" PIPING
3" HOLD 3
BLPH-MV-405
BLPH-MV-406
LO
NOTE 5
3" x 2"
2" x 0.75"
BLPH-MV-408
0.75"
BLPH-MV-409
SB
BLPH-MV-410
SB
HOLD 2
NOTE 4
1"-WW-071-01CS-E
123A90-DDL-PR-PID-80025
TO BRINE DISCHARGE CAISSON
NOTES
1. VENT TO SAFE LOCATION SEGREGATED FROM OTHER VENTS.
2. VENT TO BE EQUIPPED WITH FLAME ARRESTOR AND BIRD SCREEN.
3. LIQUID SEAL DRUM IS PART OF THE VENT SYSTEM.
4. LIQUID DRAINLINES TO BE ROUTED TO ENSURE GRAVITY DRAIN.
5. HYDROGEN VENT KO DRUM BOOT AND LIQUID SEAL DRUM TO BE HEAT TRACING.
6. SEAL LEG WILL BE DETERMINATED ON THE MAXIMUM BACK PRESSURE IN THE VENT.
7. SEAL VENT TO BE PLACED INTO A SAFE POSITION.
8. FILLING LINE TO BE PLACED IN AN ACCESSIBLE POSITION.
9. TRACED FOR 1.5 m, INSULATED UP TO THE BEND.
10. LIQUID SEAL DRUM I.D. 590 mm, HEIGHT 2350 mm (T/T). TBC BY H2 VENT VENDOR.
11. INLET DIP LEG SUBMERSION HEIGHT OF 0,2 m.
12. FLUID HEIGHT OF 1.5 m FROM BOTTOM T.L.
HOLDS
1. VENT LINES DIAMETER.
2. CONTROL VALVE SIZE (BY VENDOR).
3. TO BE CONFIRMED.
00 | 20/10/2023 | CIM | RZI | DLO | ISSUE FOR ACCEPTANCE (IFA)
REV. | DATE | DRN | CHKD | APPD | DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
HYDROGEN VENT DRUM
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN | CHECKED | APPROVED | DATE
A1
DRAWING NO. 123A90-DDL-PR-PID-80029
SHEET 001
REV. 00
File Name : FILE_NAME

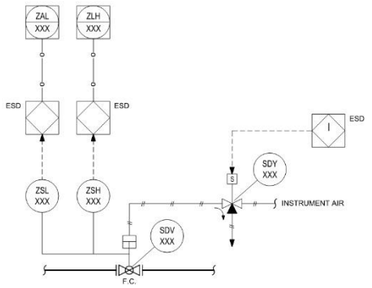

DRAWING_NO.
REV.
NOTES
DISTRIBUTION POT 1
25-FV-001
25-FV-002
25-FV-003
25-XV-004
25-XV-008
25-XV-011
DISTRIBUTION POT 2
25-FV-004
25-FV-005
25-FV-006
25-XV-014
25-XV-017
25-XV-020
DISTRIBUTION POT 6
25-XV-012
25-PV-010
25-BDV-010
DISTRIBUTION POT 3
25-XV-015
25-XV-018
25-XV-021
43-LV-001
DISTRIBUTION POT 13
64-SDV-002
64-PV-001A
64-PV-0018
DISTRIBUTION POT 4
25-PV-013
25-BDV-013
25-PV-016
25-BDV-016
25-PV-019
25-BDV-019
DISTRIBUTION POT 5
25-XV-006
25-PV-005
25-BDV-005
25-XV-009
25-PV-007
25-BDV-007
INSTR.
PIPING
1"-IA-203-01SS-N
1"-IA-204-01SS-N
1"-IA-206-01SS-N
1"-IA-208-01SS-N
1"-IA-210-01SS-N
1"-IA-212-01SS-N
1"-IA-213-01SS-N
123A90-DDL-PR-PID-80027
FROM INSTRUMENT AIR PACKAGE
1"-IA-205-01SS-N
1"-IA-207-01SS-N
1"-IA-209-01SS-N
1"-IA-211-01SS-N
1"-IA-215-01SS-N
1"-IA-214-01SS-N
1-1/2"-IA-108-01SS-N
1"-IA-191-01SS-N
123A90-DDL-PR-PID-80011
TO ELECTROLYSER PACKAGE
UPPER
D
1"-IA-194-01SS-N
123A90-DDL-PR-PID-80023
TO ULTRA FILTRATION UNIT
1"-IA-192-01SS-N
123A90-DDL-PR-PID-80022
TO SEAWATER COARSE FILTER PACKAGE
1"-IA-193-01SS-N
123A90-DDL-PR-PID-80022
TO ELECTRO CHLORINATION PACKAGE
1"-IA-195-01SS-N
123A90-DDL-PR-PID-80023
TO DESALINATION UNIT
50-FV-001
50-XV-001
50-FV-002
50-XV-002
50-XV-003
50-XV-004
DISTRIBUTION POT 7
50-FV-003
50-FV-005A
50-FV-005B
50-LV-006A
50-LV-006B
DISTRIBUTION POT 8
50-LV-007A
50-LV-007B
50-PV-013A
50-PV-013B
55-FV-001
DISTRIBUTION POT 9
25-SDV-001
25-XV-002
25-BDV-003
DISTRIBUTION POT 10
25-BDV-022
25-SDV-023
25-XV-024
25-PV-025A
25-PV-025B
DISTRIBUTION POT 11
80-XV-001
DISTRIBUTION POT 12
6
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
INSTRUMENT AIR DISTRIBUTION HEADER
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN
CHECKED
APPROVED
DATE
A1
DRAWING NO.
123A90-DDL-PR-PID-80041
SHEET 001
REV. 00
File Name : FILE_NAME

TYPICAL INSTRUMENTATION VALVE

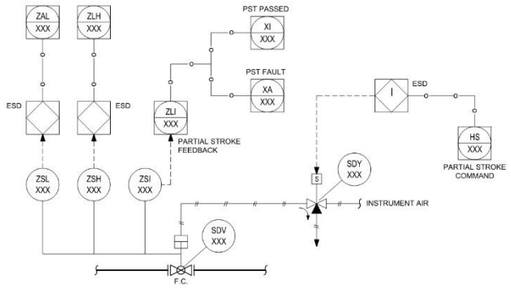
TYP.1 (XV - ON OFF VALVES)



TYP.2 (SDV - SAFETY NO CRITICAL VALVES)

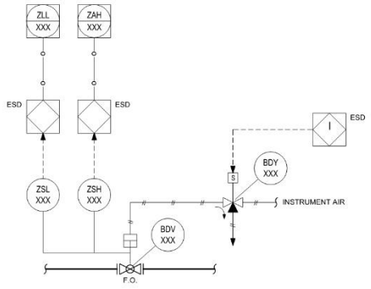


TYP.3 (SDV - SAFETY CRITICAL VALVES WITH PARTIAL STROKE)

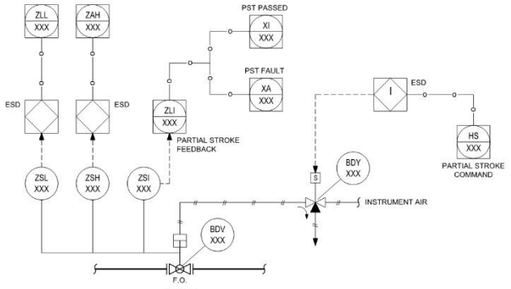


NOTE 2

TYP.4 (BDV - SAFETY NO CRITICAL VALVES)

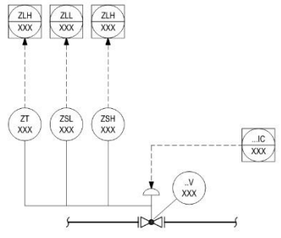


TYP.5 (BDV - SAFETY CRITICAL VALVES WITH PARTIAL STROKE)



NOTE 2

TYP.6 (CONTROL VALVE WITH POSITION TRANSMITTER)



INSTRUMENT SYMBOLOGY DEFINITION

MEANINGS OF IDENTIFICATION LETTERS
THIS TABLE APPLIES TO THE FUNCTIONAL IDENTIFICATION OF INSTRUMENTS

	FIRST- LETTER		SUCCEEDING-LETTER		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
C				CONTROL	
E			SENSOR (PRIMARY ELEMENT) ELEMENT		
F	FLOW RATE	RATIO (FRACTION)			
G			GLASS VIEWING DEVICE		
H	HAND				HIGH
I			INDICATE		
L	LEVEL				LOW
O			ORIFICE, OPEN		
P	PRESSURE, VACUUM				
R		RELIEF			
S		SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
V				VALVE, DAMPER, LOUVER	

NOTE: FOR FURTHER EXPLANATORY NOTES, REFER TO KBR STANDARDS AND ANSI/ISA-5.1

NOTES

1. FOR GENERAL NOTES AND PIPING SIMBOLOGY SEE DRAWINGS: 123A90-DDL-PR-PID-80009 AND 123A90-DDL-PR-PID-80010.
2. THE TYPICAL WILL BE CONFIRMED.

REV.	DATE	DRN.	CHKD	APPD	DESCRIPTION
00	20/10/2023	CIM	RZI	DLO	ISSUE FOR ACCEPTANCE (IFA)

CROSSWIND — ROSETTI MARINO

TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
INSTRUMENTATION SYMBOLOGY

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK			SCALE NTS
DRAWN	CHECKED	APPROVED	DATE
A1	DRAWING NO. 123A90-DDL-PR-PID-80042	SHEET 001	REV. 00

File Name:

DRAWING NO. DRAWING_NO.

REV

GENERAL NOTES

1. ALL VENTS AND DRAINS SHOWN BY THE FOLLOWING SYMBOLS REPRESENT A 3/4" VALVE.

   EXPECT AS NOTED.

   VENT/DRAIN WITH BLIND FLANGE

2. ALL VALVED CONNECTION TO ATMOSPHERE IN PROCESS SERVICE WILL BE PLUGGED OR BLIND FLANGED.
3. HIGH POINT VENTS AND LOW POINT DRAINS USED FOR HYDROTEST PURPOSES ONLY ARE PROVIDED BUT ARE NOT SHOWN ON
4. FOR GENERAL PIPING REQUIREMENTS SEE THE RELEVANT DESIGN SPECIFICATION.
5. DEFINITIONS:

   SLOPE → ELEVATION CHANGES ARE CONSTANTLY DOWNWARD ONLY, NO POCKETS ARE PERMITTED. SPECIFIC SLOPES REQUIRED ARE SHOWN BY SYMBOLS.

   WHERE NO GRADIENT IS SHOWN IT IS ASSUMED THAT THE MINIMUM PREFERED GRADIENT OF 1:100 IS USED.

   I / X

   WHERE X HAS UNITS THE SAME AS I

   GRAVITY DRAINING ELEVATION CHANGES ARE DOWNWARD ONLY. NO POCKETS ARE PERMITTED.

6. INLET LEADS TO PRESSURE RELIEF DEVICES EXCEEDING 15 m IN LENGTH OR HAVING MORE THAN TWO ELBOWS, UNLESS OTHERWISE NOTED, MUST BE APPROVED BY PROCESS ENGINEERING.
7. ALL CLOSED PRESSURE RELIEF VALVE DISCHARGE LEADS SHALL BE FREE DRAINING FROM THE PRESSURE RELIEF VALVE TO THE TOP OF THE DISCHARGE HEADER. EACH LEAD IS TO BE CHECKED FOR A DOWNWARD SLOPE AFTER CONSTRUCTION.
8. ALL PRESSURE RELIEF VALVES DISCHARGING TO ATMOSPHERE AT SAFE LOCATION SHALL CONFORM TO THE RELEVANT DESIGN SPECIFICATION.
9. FOR UNSPARED PRESSURE RELIEVING DEVICES, WHEN AN INLET BLOCK VALVE IS PROVIDED BETWEEN A VESSEL AND ITS PRESSURE RELIEVING DEVICE OR WHEN A DISCHARGE BLOCK VALVE IS PROVIDED BETWEEN A PRESSURE RELIEVING DEVICE AND A COMMON DISCHARGE HEADER, THE BLOCK VALVE SHALL BE ARRANGED SO THAT IT CAN BE LOCKED OR SEALED OPEN. UNDER NO CONDITION SHALL A DISCHARGE BLOCK VALVE BE CLOSED, WHILE THE VESSEL IS IN OPERATION, BEFORE THE INLET BLOCK VALVE IS CLOSED. THE OWNER ASSUMES RESPONSIBILITY FOR ADMINISTRATIVE CONTROL OF THESE VALVES IN STRICT ACCORDANCE WITH ASME SECTION VIII, APPENDIX M.
10. SPACE AND ACCESS IS REQUIRED FOR ON-LINE SET-POINT VERIFICATION (OLSPV) OF ALL PSV's.
11. WHEN PIPE STRAINERS ARE INDICATED, THE STRAINER BODY, SCREEN AND SIZE OF OPENINGS ARE AS SPECIFIED BY THE RELEVANT SPECIFICATION.
12. 6 MM WEEP HOLES ARE PROVIDED AT LOW POINTS OF PRESSURE RELIEF VALVE AND RUPTURE DISC DISCHARGE LINES TO ATMOSPHERE.
13. REDUCERS IN PRESSURE RELIEF VALVE INLET OR OUTLET PIPING SHALL BE MINIMUM DISTANCE FROM THE PRESSURE RELIEF VALVES.
14. DOCUMENTED ADMINSTRATIVE PROCEDURES SHALL ENSURE THAT WHENEVER SELECTED EQUIPMENT ITEMS (FOR EXAMPLE, EXCHANGERS OR FILTERS) ARE ISOLATED FOR MAINTENANCE, THEY SHALL BE VENTED AND DRAINED IMMEDIATELY.
15. LOCAL START-STOP SWITCH AT THE MOTOR ARE NOT SHOWN. DCS START-STOP FUNCTIONS ARE SHOWN AS REQUIRED.
16. TSO FOR A CONTROL VALVE WILL RESULT IN CLASS V MINIMUM SHUT OFF. ON-OFF VALVES WILL MEET API598.
17. OWNER AND DETAILED ENGINEERING CONTRACTOR SHALL DESIGN THE SAFETY INSTRUMENTED SYSTEM (SIS) IN ACCORDANCE WITH APPLICABLE PROCESS INDUSTRY STANDARDS, SUCH AS ISA S84, IEC 61511 AND IEC 61508. OWNER AND DETAILED ENGINEERING CONTRACTOR SHALL ALSO BE RESPONSIBLE FOR DEVELOPING AND IMPLEMENTING THE SAFETY INSTRUMENTED FUNCTIONS (SIF) AND PERFORMING SAFETY INTEGRITY LEVEL (SIL) DETERMINATION TO ALL SAFETY INSTRUMENTED FUNCTIONS IN ACCORDANCE WITH OWNER'S RISK MANAGEMENT POLICY.
18. THE DETAILS PROVIDED BY KBR ARE TO BE CONSIDERED AS "FOR INFORMATION ONLY" AND IS NOT REPRESENTED BY KBR TO BE IN COMPLIANCE WITH THE OWNER'S RISK MANAGEMENT CRITERIA, OR ISA S84 OR THE APPLICABLE IEC DOCUMENTS.
19. THE OWNER IS RESPONSIBLE FOR ESTABLISHING ADMINISTRATIVE CONTROLS AND PROCEDURES OF USE OF ANY SHUTDOWN SYSTEM BYPASS FEATURES FOR TESTING OR MAINTENANCE OF THE SYSTEM. ANY PROCESS INTERLOCK OF SAFETY INTEGRITY LEVEL SIL-3 SHALL NOT BE BYPASSED UNDER ANY CIRCUMSTANCES.
20. ALL THERMOWELL CONNECTIONS ARE FLANGED CONNECTIONS UNLESS OTHERWISE NOTED.
21. NEITHER FLOW INDUCED VIBRATION (FIV) NOR ACOUSTIC INDUCED VIBRATION (AIV) HAVE BEEN CONSIDERED AS A PART OF BASIC ENGINEERING DESIGN. THESE DESIGN ASPECTS ARE TO BE CONSIDERED DURING THE DETAIL ENGINEERING DESIGN PHASE.

LINE SERVICE

AV	ATMOSPHERIC VENT
CB	CONCENTRATED BRINE
CI	CHEMICAL INJECTION
DI	DEIONISED WATER
DM	DEMINERALIZED WATER
HY	HYDROGEN
IA	INSTRUMENT AIR
N	NITROGEN GAS
SWR	SEA WATER RETURN
SWS	SEA WATER SUPPLY
VL	LP VENT
WW	WASTE WATER

ABBREVIATIONS

ATM.	ATMOSPHERE
BDV	BLOWDOWN VALVE
BRS	BIRDSCREEN
CCS	CENTRAL CONTROL SERVICE
DIFF.	DIFFERENTIAL
DWG	DRAWING
ESD	EMERGENCY SHUTDOWN
FB	FULL BORE
FC	FAIL CLOSED ON LOSS OF MOTIVE POWER OR SIGNAL
FO	FAIL OPEN ON LOSS OF MOTIVE POWER OR SIGNAL
FGS	FIRE & GAS SYSTEM
GVC	GOOSENECK VENT
HH	HIGH HIGH ALARM TRIP
H	HIGH ALARM
ID	INSIDE DIAMETER
IA	INSTRUMENT AIR
L	LOW ALARM
LIP	LOCKED IN PLACE
LL	LOW LOW ALARM AND TRIP
LO	LOCKED OPEN
LP	LOW PRESSURE
M	ELECTRIC MOTOR
MCC	MOTOR CONTROL CENTER
NC	NORMALLY CLOSED
NO	NORMALLY OPEN
NPS	NOMINAL PIPE SIZE
PSV	PRESSURE SAFETY VALVE
P/T	PRESSURE/TEMPERATUE
RO	RESTRICTION ORIFICE
RS	REMOVABLE SPOOL
SAM	SAMPLE CONNECTION
SP	SPECIALITY PIPING ITEM
SPB	SPECTACLE BLIND
STR	STRAINER
TSO	TIGHT SHUT-OFF
T/T	TANGENT TO TANGENT
VB	VORTEX BREAKER

EQUIPMENT

PUMPS

CENTRIFUGAL PUMP

LIFT INLINE

STORAGE TANK

TANK

VESSEL

HORIZONTAL TANK

MISCELLANEOUS

M

MOTOR

MOTOR

PACKAGE ITEM

OTHERS

CAISSON

CAISSON

VENT STACK

NOTES

1. FOR PIPING AND INSTRUMENTATION SYMBOLOGY, SEE DRAWINGS: 123A90-DDL-PR-PID-80010 AND 123A90-DDL-PR-PID-80042

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
00	20/10/2023	CIM	RZI	DLO	ISSUE FOR ACCEPTANCE (IFA)

CROSSWIND

ROSETTI MARINO

TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
GENERAL NOTES

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK			SCALE NTS
DRAWN	CHECKED	APPROVED	DATE
A1	DRAWING NO. 123A90-DDL-PR-PID-80009	SHEET 001	REV. 00

File Name : DRAWING_NO

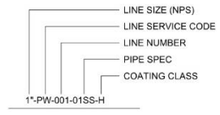
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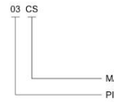
PIPING SYMBOLS

- PRIMARY PIPING
- SECONDARY PIPING
- INSULATED PIPING
- E — ELECTRICALLY HEAT TRACED PIPING

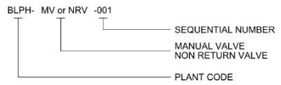
LINE NOMENCLATURE



PIPING SPECIFICATION (NOTE 4)



VALVE IDENTIFICATION CODE



PIPE CLASS RATING

01	CLASS 150# ACCORDING TO ASME B31.3
03	CLASS 300# ACCORDING TO ASME B31.3
06	CLASS 600# ACCORDING TO ASME B31.3
01H	CLASS 150# ACCORDING TO ASME B31.12
03H	CLASS 300# ACCORDING TO ASME B31.12

MATERIAL

CS	CARBON STEEL
SS	STAINLESS STEEL
SD	SUPER DUPLEX STAINLESS STEEL

INSULATION CLASS

H	HEAT CONSERVATION
P	PERSONNEL PROTECTION
E	ELECTRICALLY HEAT TRACED
N	NOT INSULATED (PAINTED)

PIPING CONNECTORS

DRAWING CONTINUATION ARROW

CONNECTOR NUMBER — XXXX | DWG NUMBER
TO/FROM EQUIPT NO.

DWG NUMBER
TO/FROM EQUIPT NO.

3RD PARTY BATTERY LIMIT

CONTRACTOR | SUPPLIER

TIE-IN LABEL
TP 100

INSTRUMENTATION CONNECTOR

DRAWING CONTINUATION ARROW

CONNECTOR NUMBER — XXXX | DWG NUMBER
TO/FROM INSTRUMENT NO.

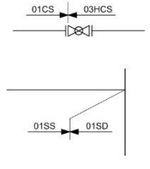
DWG NUMBER
TO/FROM INSTRUMENT NO.

VALVES, CONTROL VALVES AND RELIEF VALVES

SYMBOL	DESCRIPTION
	CHECK VALVE
	GLOBE VALVE
	BUTTERFLY VALVE
	NEEDLE VALVE
	BALL VALVE
	ANGLE VALVE
	GATE
	3-WAY
	PRESSURE RELIEF VALVE
DB	DOUBLE BLOCK AND BLEED VALVE
SB	SINGLE BLOCK AND BLEED VALVE
	SINGLE BLOCK AND BLEED VALVE (MONOFLANGE)
	DOUBLE BLOCK AND BLEED VALVE (MONOFLANGE)

PIPING SEGMENT BREAKS & LABELS

PIPE SPEC BREAK
INDICATES CHANGE PIPE SPEC



SPECIALTY LABELS

SP 0001 ← 0001 = SP SEQUENCE NO.

FITTINGS

- FLANGE
- CAP
- REDUCER
- HOSE CONNECTION

SPECIALTY ITEMS

BRS		BIRD SCREEN
STR		Y-TYPE STRAINER
	RS	REMOVABLE SPOOL
SAM	S	SAMPLE CONNECTION (SAM) SAMPLE STATION NOTE 3
GVC		GOOSENECK VENT W/MESH NOTE 3
RO		RESTRICTION ORIFICE NOTE 3
SPS		SPECTACLE BLIND (BOTTOM CIRCLE DENOTES NORMAL POSITION)
VB		VORTEX BREAKER NOTE 2

EQUIPMENT NOZZLE CONNECTIONS

- FLANGED NOZZLE
- FLANGED NOZZLE ON SIDE OF VESSEL
- MW — MANWAY
- MANWAY

INSTRUMENT LABELS

2F3
SET @ 40 barg ← SET PRESSURE

PRV SIZE (INLET, ORIFICE, OUTLET)

ACTUATORS

- DIAPHRAGM ACTUATOR
- SINGLE/DOUBLE ACTING CYLINDER ACTUATOR
- S — SINGLE SOLENOID ACTUATOR
- S — OFF-LINE 3-WAY SOLENOID VALVE WITH SINGLE ACTUATOR

INSTRUMENT SIGNAL LINES

- INSTRUMENT TO PROCESS
- ELECTRIC
- PNEUMATIC
- SOFTWARE OR CCS LINK

PRIMARY INLINE ELEMENT SYMBOLS

- VARIABLE AREA METER
- ULTRASONIC

OTHER INSTRUMENTATION

- INSTRUMENT COMPONENT LABEL SYMBOL WITH NO DATA
- 10 PV 100 A — 10 = UNIT NUMBER; P = MEASURED VARIABLE CODE; V = INSTRUMENT TYPE MODIFIER; 100 = INSTRUMENT SEQUENCE NUMBER; A = SUFFIX
- FV — CONTROL VALVE LABEL
- FV 2" FO — CONTROL VALVE WITH NOMINAL DIAMETER AND FAIL ACTION LABEL
- FIC — HH / H — ALARM HIGH HIGH LABEL / ALARM HIGH LABEL; L / LL — ALARM LOW LABEL / ALARM LOW LOW LABEL
- FT M — IF PRIMARY ELEMENT HAS INTEGRAL TRANSMITTER SHOW FT INSTEAD OF FE INSIDE OF TAG

INSTRUMENT OR FUNCTION SYMBOLS

- FIELD MOUNTED INSTRUMENT
- INSTRUMENT MOUNTED ON CENTRAL CONTROL ROOM PANEL
- DCS DISPLAY ACCESSIBLE TO OPERATOR
- CRITICAL INTERLOCK

NOTES

1. FOR GENERAL NOTES AND INSTRUMENTATION SIMBOLOGY SEE DRAWINGS: 123A90-DDL-PR-PID-80009 AND 123A90-DDL-PR-PID-80042
2. ITEMS ARE SHOWN UNDER SPECIALITY ITEMS FOR SYMBOLOGY REFERENCE ONLY. ITEMS ARE NOT SP ITEMS.
3. ITEMS ARE NOT SPECIALITY ITEMS UNLESS OTHERWISE SPECIFIED.
4. PIPE SPECIFICATION AND PIPING MATERIAL CLASS INDEX TO BE CONFIRMED IN NEXT PHASE.

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
00	20/10/2023	CIM	RZI	DLO	ISSUE FOR ACCEPTANCE (IFA)

CROSSWIND — ROSETTI MARINO

TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
PIPING SYMBOLOGY

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK | SCALE: NTS

DRAWN	CHECKED	APPROVED	DATE

A1 | DRAWING NO. 123A90-DDL-PR-PID-80010 | SHEET 001 | REV. 00

File Name : DRAWING_NO

Appendix B LOPA WORKSHEET

Node: 1. Hydrogen (Filling Operation)

Deviation	Cause	Consequence	Hazard Register	RAM Score				LOPA?	Barriers						SIF Summation - Threat	IE Type	IE Frequency	EFs		Total Event Frequency	Barrier Total PFD	MEF (/yr)	Conditional Modifiers (right-hand side barriers)			Scenario Residual Risk Frequency	Threat Res. Risk Freq.	Tolerable?			Recommendations								Res. Risk Freq. After Recs	SIF Summation - Threat	ALARP Determination
				R	S	L	RR		Barrier Tag	Barrier Description	Barrier Validity	Prevents SIF Demand?	Protective Layer Description	PFD				EF Description	EF Prob.				CM Description	CM Probability	Total CM PFD			Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Interim Measure	Resp.	HAZOP/LOPA Action	Protective Layer Description	PFD improvement	Total PFD		Residual Risk	
1.2. Flow More	1.2.4. 25XV006 Driven open/inadvertently opened by operator	1.2.4.1. Pressurise downstream system to 25PV025A/B up to 30barg. Potential to exceed design pressure (3 times design pressure) downstream of 25PV025A/B, LOPC of H2 and explosion on ignition. 25PV025A/B are downstream pressure controlled and are potentially opened when fuel cell is not online.	Hydrogen	P	5	A	5A	Y	25ZAL006[X]	Not valid as operator action to open valve.	NV					Human Error: Routine task, once per month opportunity	1.0E-01	Fuel cell in use = 135 starts/yr * 8hrs duration = 1000hrs/yr. This is roughly 10% of the time, meaning system is pressurised and therefore at risk 90% of the time.	9.0E-01	9.0E-03	1.0E-02	9.0E-05				9.0E-05		1.0E-04	Y		4. Ensure that 80PSV001 is sized for failure of downstream isolation on H2 vessel during filling operation (i.e. 25XV006) with 25PV025A or B fully open.		Rosetti Process									Recommendation 46 eliminates consequence (ALARP by design). Alternatively recommendation 22 will reduce the risk to below the tolerable frequency.
				A	4	B	4B		25ZLH006[X]	Not valid as operator action to open valve.	NV							No account taken for downtime due to maintenance estimated as 16hrs/yr.	1.0E+00									1.0E-03	Y		22. Review the required response time (PST) of 80PSV001 to ensure that it is able to react and depressurise the system quickly enough to prevent overpressure of the pipework and Fuel Cell if 25PCV025A/B are fully opened. Consider the opening times of storage vessels outlet XVs, e.g. 25XV006 and 25PV025A/B. If PSV reaction time criteria cannot be met LOPA for 25PI002 must be reviewed.		Rosetti/ Crosswind (Interface)								
				C	4	B	4B		25PIC025A/B	High Pressure alarm. Not valid as insufficient time for operator action.	NV							Unmanned platform, will be visited 1%/year, 10% assumed.	1.0E-01									1.0E-03	Y		46. As fuel cell runs down 25PIC025A/B opens 25PV025A/B. Ensure that when restart occurs 25PV025A/B are fully closed and review how the downstream pressure can be slowly increased to the point where 25PIC025A/B can be given automatic control.		Rosetti Instrumentation								
				E	3	B	3B		80PI002	High High Pressure trip of PSD closing 25SDV023.	V		SIL to be determined	1.0E+00														1.0E-02	Y											
									80PSV001	Pressure Safety Valve in clean service set point at 10barg. Valid, to be sized for this case as per recommendation.	V		RV or Vacuum Breaker (fail mode:fail to open) (Table 2#25 no Clean service reduction as Control of Personnel CM used)	1.0E-02																									

Node: 3. Hydrogen (Electricity Production)

Deviation	Cause	Consequence	Hazard Register	RAM Score				LOPA?	Barriers						SIF Summation - Threat	IE Type	IE Frequency	EFs		Total Event Frequency	Barrier Total PFD	MEF (/yr)	Conditional Modifiers (right-hand side barriers)			Scenario Residual Risk Frequency	Threat Res. Risk Freq.	Tolerable?			Recommendations								Res. Risk Freq. After Recs	SIF Summation - Threat	ALARP Determination
				R	S	L	RR		Barrier Tag	Barrier Description	Barrier Validity	Prevents SIF Demand?	Protective Layer Description	PFD				EF Description	EF Prob.				CM Description	CM Probability	Total CM PFD			Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Interim Measure	Resp.	HAZOP/LOPA Action	Protective Layer Description	PFD improvement	Total PFD		Residual Risk	
3.1. Flow No/Less	3.1.17. BLPH-MV-492 SB Left in closed position on	3.1.17.1. Upstream: Potential overpressure of pipework downstream of	Hydrogen	P	5	A	5A	Y	25PIC025A/B	High Pressure alarm. Not valid as insufficient time for operator action.	NV				80PI002	Human Error Probability (with	6.0E-03	Unmanned platform, will be visited 1%/year,	1.0E-01	6.0E-04	1.0E-02	6.0E-06				6.0E-06	2.2E-05	1.0E-04	Y		20. Ensure that 80PSV001 is verified for blocked discharge downstream of 25PV025A/B during fuel cell		Rosetti Process							2.2E-05	PHA Team considers this scenario to be ALARP and that adding additional barriers would be grossly

Node: 3. Hydrogen (Electricity Production)

Deviation	Cause	Consequence	Hazard Register	RAM Score					Barriers					SIF Summation - Threat	IE Type	IE Frequency	EFs		Total Event Frequency	Barrier Total PFD	MEF (/yr)	Conditional Modifiers (right-hand side barriers)			Scenario Residual Risk Frequency	Threat Res. Risk Freq.	Tolerable?			Recommendations							Res. Risk Freq. After Recs	SIF Summation - Threat	ALARP Determination
				R	S	L	RR		Barrier Tag	Barrier Description	Barrier Validity	Prevents SIF Demand?	Protective Layer Description	PFD				EF Description	EF Prob.				CM Description	CM Probability	Total CM PFD			Freq (/yr)	Y / N	Gap (RRF)	Recommendation	Interim Measure	Resp.	HAZOP/LOPA Action	Protective Layer Description	PFD improvement	Total PFD		Residual Risk	
	Downstream line	25PV025A/B. LOPC of H2 and potential explosion on ignition. Not included in recommendation 21/22 for LOPA as the likelihood of this cause will not be significant.		A	4	B	4B		80PI002	High High Pressure trip of PSD closing 25SDV023.	NV		SIL to be determined	1.0E+00		procedure, without checklist): HEP * number of critical steps * opportunities/yr 3E-03*1*2. First restart after error will result in event.		10% assumed.										1.0E-03	Y		operation. No consideration is made of advantageous control from 25PCV025A/B as per Shell rule set.									disproportionate to the risk reduction achieved. Additional barriers considered: //
				C	4	B	4B		80PSV001	Pressure Safety Valve set point at 10barg. Valid, to be sized for this case as per recommendation.	NV		RV or Vacuum Breaker (fail mode:fail to open) (Table 2#25 no Clean service reduction as Control of Personnel CM used)	1.0E-02													1.0E-03	Y										
				E	3	B	3B																					1.0E-02	Y										
	3.1.18. Blockage in line within Fuel Cell Package, considered to be failure to reopen main isolation valve following maintenance.	3.1.18.1. Upstream: Potential overpressure of pipework downstream of 25PV025A/B. LOPC of H2 and potential explosion on ignition.	Hydrogen	P	5	A	5A	Y	25PIC025A/B	High Pressure alarm. Not valid as insufficient time for operator action.	NV				80PI002	Human Error Probability (with procedure, without checklist): HEP * number of critical steps * opportunities/yr 3E-03*1*2. First restart after error will result in event.	6.0E-03	Unmanned platform, will be visited 1%/year, 10% assumed.	1.0E-01	6.0E-04	1.0E-02	6.0E-06				6.0E-06	2.2E-05	1.0E-04	Y		20. Ensure that 80PSV001 is verified for blocked discharge downstream of 25PV025A/B during fuel cell operation. No consideration is made of advantageous control from 25PCV025A/B as per Shell rule set.		Rosetti Process						2.2E-05	PHA Team considers this scenario to be ALARP and that adding additional barriers would be grossly disproportionate to the risk reduction achieved. Additional barriers considered: //
				A	4	B	4B		80PI002	High High Pressure trip of PSD closing 25SDV023.	NV		SIL to be determined	1.0E+00													1.0E-03	Y		21. Review the required response time (PST) of 80PI002/25SDV023 to ensure that they are able to react to prevent exceedance of hydrotest pressure of the downstream pipework and Fuel Cell if 25PCV025A/B are fully opened.		Rosetti/ Crosswind (Interface)							
				C	4	B	4B		80PSV001	Pressure Safety Valve set point at 10barg. Valid, to be sized for this case as per recommendation.	V		RV or Vacuum Breaker (fail mode:fail to open) (Table 2#25 no Clean service reduction as Control of Personnel CM used)	1.0E-02													1.0E-03	Y		22. Review the required response time (PST) of 80PSV001 to ensure that it is able to react and depressurise the system quickly enough to prevent overpressure of the pipework and Fuel Cell if 25PCV025A/B are fully opened. Consider the opening times of storage vessels outlet XVs, e.g. 25XV006 and 25PV025A/B. If PSV reaction time criteria cannot be met LOPA for 25PI002 must be reviewed.		Rosetti/ Crosswind (Interface)							
				E	3	B	3B																					1.0E-02	Y										
3.2. Flow More	3.2.5. 25PIC025A/B control failure opening 25PV025A/B	3.2.5.1. Potential overpressure of pipework downstream of 25PV025A/B. LOPC of H2 and potential explosion on ignition.	Hydrogen	P	5	A	5A	Y	25PIC025A/B	High Pressure alarm. Not valid as insufficient time for operator action also part of IE.	NV				80PI002	Control Loop (Electronic): Fails to danger	1.0E-01	Fuel cell in use = 135 starts/yr * 8hrs duration = 1000hrs/yr. This is roughly 10% of the time.	1.0E-01	1.0E-03	1.0E-02	1.0E-05				1.0E-05	2.2E-05	1.0E-04	Y		21. Review the required response time (PST) of 80PI002/25SDV023 to ensure that they are able to react to prevent exceedance of hydrotest pressure of the downstream pipework and Fuel Cell if 25PCV025A/B are fully opened.		Rosetti/ Crosswind (Interface)						2.2E-05	PHA Team considers this scenario, after implementation of recommendations, to be ALARP and that adding additional barriers would be grossly disproportionate to the risk reduction achieved. Additional barriers considered: 25PI002/25SDV003 at SIL 1
				A	4	B	4B		80PI002	High High Pressure trip of PSD closing 25SDV023.	NV		SIL to be determined	1.0E+00			Unmanned platform, will be visited 1%/year, 10% assumed.	1.0E-01									1.0E-03	Y		22. Review the required response time (PST) of 80PSV001 to ensure that it is able to react and depressurise the system quickly enough to prevent overpressure of the pipework and Fuel Cell if 25PCV025A/B are fully opened. Consider the opening times of storage		Rosetti/ Crosswind (Interface)							
				C	4	B	4B		80PSV001	Pressure Safety Valve set point at 10barg. Valid, to be sized for this case as per recommendation.	V		RV or Vacuum Breaker (fail mode:fail to open) (Table 2#25 no Clean service reduction as Control of	1.0E-02													1.0E-03	Y										

Node: 3. Hydrogen (Electricity Production)

Deviation	Cause	Consequence	Hazard Register	RAM Score				Loss?	Barriers					SIF Summation - Threat	IE Type	IE Frequency	EFs		Total Event Frequency	Barrier Total PFD	MEF (/yr)	Conditional Modifiers (right-hand side barriers)			Scenario Residual Risk Frequency	Threat Res. Risk Freq.	Tolerable?			Recommendations							Res. Risk Freq. After Recs	SIF Summation - Threat	ALARP Determination
				R	S	L	RR		Barrier Tag	Barrier Description	Barrier Validity	Prevents SIF Demand?	Protective Layer Description	PFD				EF Description	EF Prob.				CM Description	CM Probability	Total CM PFD			Freq (/yr)	Y / N	Gap (RRF)	Recommendation	Interim Measure	Resp.	HAZOP/LOPA Action	Protective Layer Description	PFD improvement	Total PFD		Residual Risk	
													Personnel CM used)																	vessels outlet XVs, e.g. 25XV006 and 25PV025A/B. If PSV reaction time criteria cannot be met LOPA for 25PI002 must be reviewed.											
				E	3	B	3B		25ZLH025[P]	Position Transmitter. Not valid as part of IE.	NV																1.0E-02	Y										
									25ZLL025[P]	Position Indicator Low. Not valid as part of IE.	NV																											
									25ZLH025[P]	Position Indicator High. Not valid as part of IE.	NV																											
3.16. Start up/ Shutdown	3.16.1. Start up of Fuel Cell 135 times/year	3.16.1.1. Potential for overpressurisation of line and Fuel Cell downstream of 25PCV025A/B due to reaction speed of 25PIC025A/B. Insufficient time for control system to react to prevent downstream overpressure. Assumption is that as fuel cell runs down 25PIC025A/B opens 25PV025A/B such that when restart occurs 25PV025A/B are fully open.	Hydrogen	P	5	A	5A	Y	80PI002	High High Pressure trip of PSD closing 25SDV023. Potentially insufficient time to prevent rupture of pipework or Fuel Cell, however likely to be able to prevent large LOPC from loss of H2 vessel inventory. Review in Interface HAZOP for Rosetti/Fuel Cell [Parking Lot; What: Review in Interface HAZOP for Rosetti/Fuel Cell]	NV		This is the normal start-up protective system should not be in used for this event.			Normal Start-up of Power generation this 135 per year	1.4E+02	Unmanned platform, will be visited 1%/year, 10% assumed.	1.0E-01	1.4E+01		1.4E+01			1.4E+01			1.0E-04	N	135000	46. As fuel cell runs down 25PIC025A/B opens 25PV025A/B. Ensure that when restart occurs 25PV025A/B are fully closed and review how the downstream pressure can be slowly increased to the point where 25PIC025A/B can be given automatic control.		Rosetti Instrumentation							Recommendation eliminates consequence (ALARP by design).
				A	4	B	4B		80PSV001	Pressure Safety Valve. May not be valid as potential insufficient time for spring operated PSV to react due to volumes in line. Review in Interface HAZOP for Rosetti/Fuel Cell [Parking Lot; What: Review in Interface HAZOP for Rosetti/Fuel Cell]	NV		This is the normal start-up protective system should not be in used for this event.															1.0E-03	N	13500										
				C	4	B	4B																						1.0E-03	N	13500										
				E	3	B	3B																						1.0E-02	N	1350										

Appendix C HAZOP WORKSHEETS

The HAZOP worksheets from the integrated HAZOP & LOPA process are given below for information only. For the definitive worksheets and list of recommendations please refer to the HAZOP report [Ref. 4].

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
1.1. Flow No/Less	1.1.1. No H2 from Electrolyser Package	1.1.1.1. No H2 from upstream any consequence leading to delay in fill up of H2 storage. No hazardous consequences.																															
		1.1.1.2. Potential reverse flow from V-25001A to Electrolyser package leading to 30 barg H2 back into Electrolyser Package. Review with Elogen HAZOP. Refer to 3.3.1.																															
	1.1.2. BLPH-MV-003 DBB Left in closed position	1.1.2.1. Upstream: Blocked outlet for Electrolyser package during start-up. Refer to Elogen HAZOP Node 6.																															
		1.1.2.2. Downstream: No H2 from upstream any consequence leading to delay in fill up of H2 storage. No hazardous consequences. Vessel V-25001A maybe filled with N2 or H2 at 0barg.																															
	1.1.3. 25SDV001 Fails closed Consequence: 1.1.6.1 Consequence: 1.1.7.1 Consequence: 1.1.8.1 Consequence: 1.13.1.1	1.1.3.1. Upstream: Blocked outlet for Electrolyser package during start-up. Refer to Elogen HAZOP Node 6.								25ZLH001[S]	Loss of 25ZLH001 High position indicator.																							
										25ZAL001[S]	25ZAL001 Low position indicator alarm will be activated.																							
		1.1.3.2. Upstream: High pressure in H2 manifold system, max pressure of 40barg, no hazardous consequences.								System DP	Design pressure of system is 40barg.																							
		1.1.3.3. Downstream: No H2 from upstream any consequence leading to delay in fill up of H2 storage. No hazardous consequences. Vessel V-25001A maybe filled with N2 or H2 at 0barg.								25ZLH001[S]	Loss of 25ZLH001 High position indicator.																							
										25ZAL001[S]	25ZAL001 Low position indicator alarm will be activated.																							
	1.1.4. BLPH-MV-010 DBB Left in closed position on Hydrogen vent line	1.1.4.1. Normally open in filling operation.																															
	1.1.5. 25XV003 fails closed on Hydrogen vent line	1.1.5.1. Normally closed in filling operation.																															
	1.1.6. 25XV004 Fails closed	1.1.6.1. Refer to Cause 1.1.3 Cause: 1.1.3																															
	1.1.7. BLPH-MV-029 DBB Left in closed position on Vessel inlet stream	1.1.7.1. Refer to Cause 1.1.3 Cause: 1.1.3																															
	1.1.8. Spectacle Blind on Inlet Stream	1.1.8.1. Refer to Cause 1.1.3 Cause: 1.1.3																															
	1.1.9. BLPH-MV-032 DBB Left in closed position	1.1.9.1. Loss of safeguard for pressure relief.								LO Valve	BLPH-MV-032 is a LO valve																							

Node: 1. Hydrogen (Filling Operation)

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
	on Hydrogen Vent																																	
	1.1.10. BLPH-MV-034 DBB Left in closed position on Blowdown System	1.1.10.1. Unable to depressurise V25001A when required leading to a delay in maintenance, no hazardous consequences, but contrary to MAH operational philosophy for POB.								25PI004	Pressure indication would show that the vessel V25001A is not fully depressurised. Normal procedure to check pressure indication prior to deploying Maintenance to site. Indication should read 0barg.																								
										25PIC005	Pressure indication would show that the vessel V25001A is not fully depressurised. Normal procedure to check pressure indication prior to deploying Maintenance to site. Indication should read 0barg.																								
	1.1.11. 25PV005 Fails closed	1.1.11.1. Normally closed in filling operation, only used for purge operation. No hazardous consequences.																																
	1.1.12. 25BDV005 Fails closed on Blowdown Stream	1.1.12.1. Normally closed in filling operation.																																
	1.1.13. Spectacle Blind on Discharge Line	1.1.13.1. No impact if closed during filling operation, no hazardous consequences.																																
	1.1.14. BLPH-MV-086 DBB Left in closed position on Discharge Line	1.1.14.1. No impact if closed during filling operation, no hazardous consequences.																																
	1.1.15. 25XV006 Failed closed on Discharge Line	1.1.15.1. No impact if closed during filling operation, no hazardous consequences.																																
	1.1.16. Spectacle Blind on Waste Water Line	1.1.16.1. Normally closed in filling operation.																																
	1.1.17. 25FV001 N2 valve	1.1.17.1. Normally closed in filling operation.																																
	1.1.18. BLPH-MV-088 DBB Left in closed position on N2 Line	1.1.18.1. No impact if closed during filling operation, no hazardous consequences.																																
	1.1.19. Spectacle Blind on N2 Line	1.1.19.1. No impact if closed during filling operation, no hazardous consequences.																																
1.2. Flow More	1.2.1. 25SDV001 Driven Open when required to be closed by ESD	1.2.1.1. Failure of ESD valves in their none failure direction is not considered within this HAZOP.																																
	1.2.2. 25BDV005 Fails open/inadvertently opened by operator	1.2.2.1. H2 sent to H2 vent header and vented to atmosphere, loss of product. Potential for fire/explosion of continuously vented H2 at top of H2 vent.	Hydrogen	P	5	A	5A	N		43FI001	High Flow indication on vent.	NV																	1. Review the requirement for an alarm on 43FT001 and if required determine an appropriate set point to indicate continuous high pressure blowdown of H2 storage vessels.	Rosetti Process			Recommendation eliminates consequence (ALARP by design).
				A	4	B	4B			25PI004	Reducing Pressure indication in V25001A.	NV																	2. Perform vent radiation and dispersion study to confirm that	Rosetti Tech Safety			
				C	4	B	4B			25PT005	Reducing Pressure indication in V25001A	NV																						

Node: 1. Hydrogen (Filling Operation)

Deviation	Cause	Consequence	Hazard Register	RAM R	RAM S	RAM L	RAM RR	LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs EF Description	EFs EF Prob.	Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs CM Description	CMs CM Prob.	CMs Total CM PFD	Res. Risk. Freq.	Tolerable? Freq (/yr)	Tolerable? Y/N	Tolerable? Gap (RRF)	Recommendations	Recommendations Resp.	Recommendations PFD Improved	Res. Risk Freq. After Recs	ALARP Determination
		A single H2 storage vessel can be depressurised while maintaining pressure in the other vessels.		E	3	B	3B			Classification and Hazardous Zoning	Area classification and hazardous area zoning to minimise ignition potential.																			dispersion from continuous blowdown or fail open of: 1. 25PV005 of any single H2 storage vessel 2. 25XV003 (25RO003) 3. 25BDV005 (25RO005) 4. 80XV001 (80RO001) 5. 25BDV022 (25RO022) does not create a fire or explosion risk to the installation.				
										25ZLL005[B]	Position Indicator Low. Not valid as part of IE.	NV																				
										25ZAH022[B]	Position Indicator High alarm. Not valid as part of IE.	NV																				
	1.2.3. 25PIC005 failure opening 25PV005	1.2.3.1. H2 sent to H2 vent header and vented to atmosphere, loss of product. Potential for fire/explosion of continuously vented H2 at top of H2 vent. A single H2 storage vessel can be depressurised while maintaining pressure in the other vessels.	Hydrogen	P	5	A	5A	N		43FI001	High Flow indication on vent.																			1. Review the requirement for an alarm on 43FT001 and if required determine an appropriate set point to indicate continuous high pressure blowdown of H2 storage vessels.	Rosetti Process			Recommendation eliminates consequence (ALARP by design).
				A	4	B	4B			25PI004	Reducing Pressure indication in V25001A.																			2. Perform vent radiation and dispersion study to confirm that dispersion from continuous blowdown or fail open of: 1. 25PV005 of any single H2 storage vessel 2. 25XV003 (25RO003) 3. 25BDV005 (25RO005) 4. 80XV001 (80RO001) 5. 25BDV022 (25RO022) does not create a fire or explosion risk to the installation.	Rosetti Tech Safety			
				C	4	B	4B			25PT005	Reducing Pressure indication in V25001A																			3. Review if it is credible to implement an interlock on 25PIC005 to prevent 25PV005 being opened outside of a purge cycle operation.	Rosetti Process			
				E	3	B	3B			Classification and Hazardous Zoning	Area classification and hazardous area zoning to minimise ignition potential.																						
										25ZLH005[P]	Position Transmitter. Not valid as part of IE.	NV																				
										25ZLL005[P]	Position Indicator Low. Not valid as part of IE.	NV																				
										25ZLH005[P]	Position Indicator High. Not valid as part of IE.	NV																				
	1.2.4. 25XV006 Driven open/inadvertently opened by operator	1.2.4.1. Pressurise downstream system to 25PV025A/B up to 30barg. Potential to exceed design pressure (3 times design pressure) downstream of 25PV025A/B, LOPC of H2 and explosion on ignition. 25PV025A/B are downstream pressure controlled and are potentially opened when fuel cell is not online.	Hydrogen	P	5	A	5A	Y		25ZAL006[X]	Not valid as operator action to open valve.	NV				Human Error: Routine task, once per month opportunity	1.0E-01	Fuel cell in use = 135 starts/yr * 8hrs duration = 1000hrs/yr. This is roughly 10% of the time, meaning system is pressurised and therefore at risk 90% of the time.	9.0E-01	9.0E-03	1.0E-02	9.0E-05				9.0E-05	1.0E-04	Y		4. Ensure that 80PSV001 is sized for failure of downstream isolation on H2 vessel during filling operation (i.e. 25XV006) with 25PV025A or B fully open.	Rosetti Process			Recommendation 46 eliminates consequence (ALARP by design). Alternatively recommendation 22 will reduce the risk to below the tolerable frequency.
				A	4	B	4B			25ZLH006[X]	Not valid as operator action to open valve.	NV						No account taken for downtime due to maintenance estimated as 16hrs/yr.	1.0E+00								1.0E-03	Y		22. Review the required response time (PST) of 80PSV001 to ensure that it is able to react and depressurise the system quickly enough to prevent overpressure of the pipework and Fuel Cell if 25PCV025A/B are fully opened.	Rosetti/Crosswind (Interface)			

Node: 1. Hydrogen (Filling Operation)

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
																														Consider the opening times of storage vessels outlet XVs, e.g. 25XV006 and 25PV025A/B. If PSV reaction time criteria cannot be met LOPA for 25PI002 must be reviewed.				
				C	4	B	4B			25PIC025A/B	High Pressure alarm. Not valid as insufficient time for operator action.	NV						Unmanned platform, will be visited 1%/year, 10% assumed.	1.0E-01								1.0E-03	Y		46. As fuel cell runs down 25PIC025A/B opens 25PV025A/B. Ensure that when restart occurs 25PV025A/B are fully closed and review how the downstream pressure can be slowly increased to the point where 25PIC025A/B can be given automatic control.	Rosetti Instrumentation			
				E	3	B	3B			80PI002	High High Pressure trip of PSD closing 25SDV023.	V	SIL to be determined	1.0E+00													1.0E-02	Y						
										80PSV001	Pressure Safety Valve in clean service set point at 10barg. Valid, to be sized for this case as per recommendation.	V	RV or Vacuum Breaker (fail mode:fail to open) (Table 2#25 no Clean service reduction as Control of Personnel CM used)	1.0E-02																		
	1.2.5. 25FIC001 failure opening 25FV001 N2 valve	1.2.5.1. Potential for N2 (7barg) into H2 storage vessel V25001A during filling operation resulting in off spec H2 sent to the Fuel Cell leading to operational issue no hazardous consequences as per Fuel Cell HAZOP (Cause 1.13.1). Consequence: 1.13.2.1										No barriers within Rosetti scope, refer to Fuel cell HAZOP.																		6. Review if it is credible to implement an interlock to prevent 25FV001 being opened outside of a purge cycle operation.	Rosetti Process			
		1.2.5.2. Potential for H2 (up to 30barg) into N2 system resulting in H2 being used in place of N2 in Electrolyser systems. Refer to Elogen HAZOP node 10.																																
		1.2.5.3. Overpressure of N2 system resulting in LOPC of H2 and N2.	Hydrogen	P	5	A	5A	N		BLPH-NRV-014	Non-return valve.	NV																		7. Review the current design against for compliance with piping (utility connection DEP 31.38.01.11, version 2018) and overpressure (80.45.10.11) DEPs for connection of utility N2 to H2 storage vessels V25001A-F. If they are not compliant (and are not to be made compliant) review current design with LOPA.	Rosetti Process			To be determined / re-evaluated after closeout of recommendation.
				A	4	B	4B			64PIC001A	High Pressure alarm with operator action. Not valid as insufficient time.	NV																		8. Ensure that 64PSV001 is verified for backflow of 30 barg H2 from storage vessels V25001A-F. Ensure that the vent from PSV is located in a safe location considering this flow will be H2. Also consider proximity of vent to N2 package which vents O2.	Rosetti Process			
				C	4	B	4B			64PIC001B	High Pressure alarm with operator action. Not valid as insufficient time.	NV																						
				E	3	B	3B			64PSV001	Pressure Safety Valve set point at 10barg.	NV																						
										25ZLH005[F]	Position Transmitter. Not valid as part of IE.	NV																						
										25ZLL005[F]	Position Indicator Low. Not valid as part of IE.	NV																						
										25ZLH005[F]	Position Indicator High. Not valid as part of IE.	NV																						
		1.2.5.4. H2 reverse flow into N2 package U64000. Review consequences within HAZOP of N2 package. [Parking Lot; What: N2 package HAZOP]																																

Node: 1. Hydrogen (Filling Operation)

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
1.3. Flow Misdirected	1.3.1. 25XV003 inadvertently open by operator	1.3.1.1. H2 sent to H2 vent header and vented to atmosphere, loss of product. Potential for fire/explosion of continuously vented H2 at top of H2 vent.	Hydrogen	P	5	A	5A	N		43FI001	High Flow indication on vent.																			1. Review the requirement for an alarm on 43FT001 and if required determine an appropriate set point to indicate continuous high pressure blowdown of H2 storage vessels.	Rosetti Process			Recommendation eliminates consequence (ALARP by design).
				A	4	B	4B			25PI004	Reducing Pressure indication in V25001A.																			2. Perform vent radiation and dispersion study to confirm that dispersion from continuous blowdown or fail open of: 1. 25PV005 of any single H2 storage vessel 2. 25XV003 (25RO003) 3. 25BDV005 (25RO005) 4. 80XV001 (80RO001) 5. 25BDV022 (25RO022) does not create a fire or explosion risk to the installation.	Rosetti Tech Safety			
				C	4	B	4B			25PT005	Reducing Pressure indication in V25001A																							
				E	3	B	3B			Classification and Hazardous Zoning	Area classification and hazardous area zoning to minimise ignition potential.																							
										25ZAL003[X]	Position Indicator Low. Not valid as part of IE.	NV																						
										25ZLH003[X]	Position Indicator High alarm. Not valid as part of IE.	NV																						
	1.3.2. 25XV008/11/14/17/20 open when not required and V25001B-F is at low pressure. Consequence: 1.5.1.1	1.3.2.1. Rapid increase in Pressure in vessels V25001B-F from 0 to 30barg. Potential for exceeding design velocity or high vibration in piping and vessels V25001B-F leading to potential LOPC of H2.	Hydrogen	P	5	A	5A	N		None Identified																				14. Determine if high DP across any valves (likely to be up to 30bar) has the potential for high velocity (outside of pipe spec) or high vibration with the potential to damage pipework. If so consider how purging cycle can be performed without using SDV.	Rosetti Process			Recommendation eliminates consequence (ALARP by design).
				A	4	B	4B																											
				C	4	B	4B																											
				E	3	B	3B																											
1.4. Flow As Well As	1.4.1. No additional causes.																																	
1.5. Flow Reverse	1.5.1. 25XV008/11/14/17/20 open when not required and V25001B-F is at High pressure (30barg).	1.5.1.1. Refer to 1.3.2: Cause: 1.3.2																																
1.6. Pressure Low	1.6.1. No additional causes.																																	
1.7. Pressure High	1.7.1. External Fire Consequence: 3.7.1.1	1.7.1.1. Potential overpressure of H2 storage vessel V25001A resulting in LOPC of H2 and explosion on ignition.	Hydrogen	P	5	A	5A	N		25PSV001	Pressure Safety Valve designed for fire case.	V																			9. Review the ESD logic for activation of ESD 1D on activation of 25PI004 HH and F&G detection system. Consider under which circumstances a single vessel should be depressurised and when all vessels should be depressurised.	Rosetti Tech Safety			ALARP by HSSE Standards and Practices. Assessment based on: Shell overpressure DEP.
				A	4	B	4B			25PI004	High High pressure trip of ESD 1D with blowdown valve 25BDV005.																							
				C	4	B	4B			F&G Detection	F&G Detection system will trigger ESD 1D and open all BDV valves on V25001A-F.																							
				E	3	B	3B																											
	1.7.2. High pressure from Electrolyser	1.7.2.1. 36 barg (set point of PSV on Electrolyser) H2 from Electrolyser. Design pressure of storage system is 40barg, no hazardous consequences.								Elogen HPP700 PAH	High pressure alarm in Electrolyser package. TBC by Elogen HAZOP node 6.																							
										Elogen HPP700 PAHH	High High pressure trip in Electrolyser package of Electrolyser Package. TBC by Elogen HAZOP node 6.																							
										Elogen PSV631	Pressure Safety Valve set point at 36barg. Sized for blocked outlet case.																							
										25PI001	High Pressure alarm																							
										25PI002	High High pressure trip of PSD isolating H2 storage from Electrolyser by closing 25SDV001.																							
										25PI004	High High pressure trip of ESD 1D with blowdown valve 25BDV005.																							

Node: 1. Hydrogen (Filling Operation)

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
1.8. Temperature Low	1.8.1. Low ambient temperature	1.8.1.1. No hazardous consequences.																																
1.9. Temperature High	1.9.1. No additional causes.																																	
1.10. Level No/Low	1.10.1. No credible causes																																	
1.11. Level High	1.11.1. No credible causes																																	
1.12. Phase	1.12.1. No credible causes																																	
1.13. Composition/Contamination	1.13.1. Moisture due to failure of HPP	1.13.1.1. Potential for ice formation within H2 system under cold ambient conditions. Potential blocked discharge of Electrolyser. Refer to cause 1.1.3: Cause: 1.1.3								Elogen DPT800A/B	Dew Point Analysers divert H2 stream to vent if above moisture specification within Elogen Package.																							
	1.13.2. N2 due to passing of 25FV001 during initial filling	1.13.2.1. Refer to consequence 1.2.5.1: Consequence: 1.2.5.1																																
	1.13.3. N2 from Electrolyser Package	1.13.3.1. Potential for N2 into H2 storage vessel V25001A during filling operation resulting in off spec H2 sent to the Fuel Cell leading to operational issue no hazardous consequences as per Fuel Cell HAZOP (Cause 1.13.1).								Elogen Timed Purge	Elogen Purge H2 stream to vent for timed period following cold start-up to ensure all N2 is removed from the H2 stream.																							
	1.13.4. O2 contamination of H2 in the storage system	1.13.4.1. O2 contamination of H2 in the storage system. Potential for explosion in H2 storage vessel. For flammable concentration to be formed within the H2 storage vessel O2 would have to accumulate within the vessel and not be flushed out.	Hydrogen	P	5	A	5A	N		Elogen stack	Maximum concentration that can be produced by stack is 500ppm O2.																			24. Review with Fuel Cell suppliers what the consequence of 500ppm of O2 in the H2 stream will be on the Fuel Cell. Will this be only be an impact on performance or likely to create a hazard? If credible hazard consider LOPA for Elogen OIHA800A/B.	Rosetti/Crosswind Project			To be determined / re-evaluated after closeout of recommendation.
				A	4	B	4B			Elogen OIHA800A/B	Oxygen Analyser divert H2 stream to vent if above Oxygen specification within Elogen Package.																			25. Perform a calculation to determine how long/number of fill cycles it would require for a flammable concentration to be formed within the H2 storage vessel based on 500ppm O2 to determine if a flammable concentration is credible in the H2 storage vessel.	Rosetti Process			
				C	4	B	4B			Ignition Sources	No ignition sources within H2 Storage system. Static ignition sources suppressed with Earth bonding.																							
				E	3	B	3B																												
1.14. Operations	1.14.1. No additional causes.																																	
1.15. Maintenance	1.15.1. Maintenance of Relief Valves	1.15.1.1. Lifting of relief valves in to place during maintenance review requirement for accessibility and temporary lifting equipment. [Parking Lot; What: To be reviewed]																																

Node: 1. Hydrogen (Filling Operation)

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
1.16. Start up/ Shutdown	1.16.1. Re-start after trip	1.16.1.1. Potential for operators to board the platform while it is still pressurised with Gas.								Shutdown philosophy	For PSD and ESD1 remote start is available without POB. For ESD 1D and ASD platform is depressurised and personnel may board.																								
1.17. Catalysts	1.17.1. No credible causes																																
1.18. Utilities	1.18.1. Loss of Power Consequence: 3.18.1.1 Consequence: 2.18.1.1	1.18.1.1. Breakers can be reset remotely. If personnel are required to go to the platform following an ESD 1, blowdown valves can be opened using the UPS.																															
	1.18.2. Loss of Instrument Air Consequence: 2.18.2.1	1.18.2.1. Section of line between 25SDV001 and 25XV004 will be blocked in during ESD scenario.																											10. Review the requirement for a BDV (FO) with a bypass around (25XV003 and 25RO003) and (80XV001 and 80RO001) to allow emergency depressurisation on the manifold inlet line. See also recommendation 12.	Rosetti Process			
																													11. Ensure that the trapped volume between 25SVD023 and 25PV025A/B is minimised such that it does not require blowdown.	Rosetti Process			
																													12. Review the trapped volume between Fuel Cell Package and 25PV025A/B is minimised such that it does not require blowdown or consider providing a blowdown route. See also recommendation 10.	Rosetti Process			
	1.18.3. Loss of Nitrogen Supply	1.18.3.1. No hazardous consequences.																															
1.19. Corrosion/ Erosion	1.19.1. No additional causes.																																
1.20. Other	1.20.1. DC systems	1.20.1.1. Potential for electrically induced corrosion.																											13. Ensure that the potential for electrically induced corrosion and requisite earthing is considered in the SAFOP.	Crosswind Electrical			

Node: 2. Hydrogen (Purging)

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
2.1. Flow No/Less	2.1.1. No H2 from Electrolyser Package	2.1.1.1. Unable to pulse purge with H2 leading to a delay in start-up.																															
		2.1.1.2. Potential for backflow of N2 to Electrolyser Package, small flow as N2 is at low pressure. No hazardous consequences.																															
	2.1.2. BLPH-MV-003 DBB Left in closed position	2.1.2.1. Upstream: Blocked outlet for Electrolyser package during start-up. Refer to Elogen HAZOP Node 6.																															

Node: 2. Hydrogen (Purging)

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
		2.1.2.2. Unable to pulse purge with H2 leading to a delay in start-up.																																
	2.1.3. 25SDV001 Fails closed	2.1.3.1. Upstream: Blocked outlet for Electrolyser package during start-up. Refer to Elogen HAZOP Node 6.								25ZLH001[S]	Loss of 25ZLH001 High position indicator.																							
										25ZAL001[S]	25ZAL001 Low position indicator alarm will be activated.																							
		2.1.3.2. Upstream: High pressure in H2 manifold system, max pressure of 40barg, no hazardous consequences.								System DP	Design pressure of system is 40barg.																							
		2.1.3.3. Unable to pulse purge with H2 leading to a delay in start-up.																																
	2.1.4. BLPH-MV-010 DBB Left in closed position on Hydrogen vent line	2.1.4.1. Unable to purge inlet line of N2 leading to a delay in start-up, no hazardous consequence.																																
	2.1.5. 25XV003 fails closed on Hydrogen vent line Consequence: 4.1.2.1 Consequence: 4.1.3.1	2.1.5.1. Unable to purge inlet line of N2 leading to a delay in start-up, no hazardous consequence.								25ZLH003[X]	Position Indicator High																							
										25ZAL003[X]	Position Indicator Low alarm																							
	2.1.6. 25XV004 Fails closed Consequence: 2.1.7.1 Consequence: 2.1.8.1	2.1.6.1. Unable to purge vessel V25001A of N2 leading to a delay in start-up, no hazardous consequence.								25ZLH004[X]	Position Indicator High																							
										25ZAL004[X]	Position Indicator Low alarm																							
	2.1.7. BLPH-MV-029 DBB Left in closed position on Vessel inlet stream	2.1.7.1. Refer to 2.1.6: Cause: 2.1.6																																
	2.1.8. Spectacle Blind on Inlet Stream	2.1.8.1. Refer to 2.1.6: Cause: 2.1.6																																
	2.1.9. BLPH-MV-032 DBB Left in closed position on Hydrogen Vent	2.1.9.1. Loss of safeguard for pressure relief.								LO Valve	BLPH-MV-032 is a LO valve																							
	2.1.10. BLPH-MV-034 DBB Left in closed position on Blowdown System	2.1.10.1. Unable to purge V25001A when required leading to a delay in start-up, no hazardous consequences.								25PI004	Pressure indication would show that the vessel V25001A is not fully depressurised. Normal procedure to check pressure indication prior to deploying Maintenance to site. Indication should read 0barg.																							
										25PIC005	Pressure indication would show that the vessel V25001A is not fully depressurised. Normal procedure to check pressure indication prior to deploying Maintenance to site. Indication should read 0barg.																							
	2.1.11. 25PV005 Fails closed	2.1.11.1. Unable to purge V25001A when required leading to a								25PI004	Pressure indication would show that the vessel V25001A is not fully depressurised. Normal procedure to check pressure																							

Node: 2. Hydrogen (Purging)

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
	Consequence: 4.1.5.1	delay in start-up, no hazardous consequences.									indication prior to deploying Maintenance to site. Indication should read 0barg.																						
										25PIC005	Pressure indication would show that the vessel V25001A is not fully depressurised. Normal procedure to check pressure indication prior to deploying Maintenance to site. Indication should read 0barg.																						
										25ZLH005[P]	Position Transmitter																						
										25ZLL005[P]	Position Indicator Low																						
										25ZLH005[P]	Position Indicator High																						
	2.1.12. 25BDV005 Fails closed on Blowdown Stream	2.1.12.1. Normally closed during purge operation.																															
	2.1.13. Spectacle Blind on Discharge Line Consequence: 2.1.14.1 Consequence: 2.1.16.1	2.1.13.1. Unable to purge system downstream of vessel, delay in start-up, no hazardous consequences.																															
	2.1.14. BLPH-MV-086 DBB Left in closed position on Discharge Line	2.1.14.1. Refer to 2.1.13: Cause: 2.1.13																															
	2.1.15. 25XV006 Failed closed on Discharge Line during purge of vessel	2.1.15.1. Normally closed during purge operation.																															
	2.1.16. 25XV006 Failed closed on Discharge Line during purge of Downstream line	2.1.16.1. Refer to 2.1.13: Cause: 2.1.13								25ZLH006[X]	Position Indicator High																						
										25ZAL006[X]	Position Indicator Low alarm																						
	2.1.17. Spectacle Blind on Waste Water Line	2.1.17.1. Normally closed during purge operation.																															
	2.1.18. 25FV001 N2 valve	2.1.18.1. Normally closed during H2 purge operation.																															
	2.1.19. Spectacle Blind on N2 Line	2.1.19.1. No impact if closed during purge operation, no hazardous consequences.																															
	2.1.20. 25BDV022 fails closed	2.1.20.1. No impact if closed during purge operation, no hazardous consequences.								25ZLL022[B]	Position Indicator Low																						
										25ZAH022[B]	Position Indicator High alarm																						
	2.1.21. BLPH-MV-018 DBB Left in closed position on Downstream blowdown line	2.1.21.1. No impact if closed during purge operation, no hazardous consequences.																															
										25ZAL001[S]	Position Indicator Low alarm																						

Node: 2. Hydrogen (Purging)

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
	2.1.22. 25SDV023 Fails closed	2.1.22.1. Unable to purge system downstream of vessel, delay in start-up, no hazardous consequences.								25ZLH001[S]	Position Indicator High																							
	2.1.23. 25PV025A/B Fails closed	2.1.23.1. Unable to purge system downstream of vessel, delay in start-up, no hazardous consequences.								25ZLH025[F]	Position Transmitter																							
										25ZLL025[F]	Position Indicator Low																							
										25ZLH025[F]	Position Indicator High																							
	2.1.24. BLPH-MV-006 SB Left in closed position on Downstream Relief line	2.1.24.1. Loss of safeguard																																
	2.1.25. BLPH-MV-007 SB Left in closed position on Downstream purge line	2.1.25.1. Unable to purge system downstream of vessel, delay in start-up, no hazardous consequences.																																
	2.1.26. 80XV001 Fails closed	2.1.26.1. Unable to purge system downstream of vessel, delay in start-up, no hazardous consequences.								80ZLH001[X]	Position Indicator High																							
										80ZAL001[X]	Position Indicator Low alarm																							
	2.1.27. BLPH-MV-492 SB Left in closed position on Downstream line	2.1.27.1. Unable to purge system downstream of vessel, delay in start-up, no hazardous consequences. This is a dead leg in purge system and distance is minimised to Fuel Cell Package.																																
2.2. Flow More	2.2.1. 25SDV001 Driven Open when required to be closed by ESD	2.2.1.1. Failure of ESD valves in their none failure direction is not considered within this HAZOP.																																
	2.2.2. 25BDV005 Fails open/inadvertently opened by operator	2.2.2.1. H2 sent to H2 vent header and vented to atmosphere, loss of product. Potential for fire/explosion of continuously vented H2 at top of H2 vent. A single H2 storage vessel can be depressurised while maintaining pressure in the other vessels.	Hydrogen	P	5	A	5A	N		43FI001	High Flow indication on vent.																				1. Review the requirement for an alarm on 43FT001 and if required determine an appropriate set point to indicate continuous high pressure blowdown of H2 storage vessels.	Rosetti Process			Recommendation eliminates consequence (ALARP by design).
				A	4	B	4B			25PI004	Reducing Pressure indication in V25001A.																				2. Perform vent radiation and dispersion study to confirm that dispersion from continuous blowdown or fail open of: 1. 25PV005 of any single H2 storage vessel 2. 25XV003 (25RO003) 3. 25BDV005 (25RO005) 4. 80XV001 (80RO001) 5. 25BDV022 (25RO022) does not create a fire or explosion risk to the installation.	Rosetti Tech Safety			
				C	4	B	4B			25PT005	Reducing Pressure indication in V25001A																							
				E	3	B	3B			Classification and Hazardous Zoning	Area classification and hazardous area zoning to minimise ignition potential.																							
										25ZAH022[B]	Position Indicator High alarm. Not valid as part of IE.	NV																						
										25ZLL005[B]	Position Indicator Low. Not valid as part of IE.	NV																						
	2.2.3. 25PIC005 failure opening 25PV005	2.2.3.1. H2 sent to H2 vent header and vented to atmosphere, loss of product. Potential for fire/explosion of	Hydrogen	P	5	A	5A	N		43FI001	High Flow indication on vent.																				1. Review the requirement for an alarm on 43FT001 and if required determine an appropriate set point to indicate continuous high pressure blowdown of H2 storage vessels.	Rosetti Process			Recommendation eliminates consequence (ALARP by design).

Node: 2. Hydrogen (Purging)

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
		continuously vented H2 at top of H2 vent. A single H2 storage vessel can be depressurised while maintaining pressure in the other vessels.		A	4	B	4B			25PI004	Reducing Pressure indication in V25001A.																			2. Perform vent radiation and dispersion study to confirm that dispersion from continuous blowdown or fail open of: 1. 25PV005 of any single H2 storage vessel 2. 25XV003 (25RO003) 3. 25BDV005 (25RO005) 4. 80XV001 (80RO001) 5. 25BDV022 (25RO022) does not create a fire or explosion risk to the installation.	Rosetti Tech Safety			
				C	4	B	4B			25PT005	Reducing Pressure indication in V25001A																			3. Review if it is credible to implement an interlock on 25PIC005 to prevent 25PV005 being opened outside of a purge cycle operation.	Rosetti Process			
				E	3	B	3B			Classification and Hazardous Zoning	Area classification and hazardous area zoning to minimise ignition potential.																						
										25ZLH005[P]	Position Transmitter. Not valid as part of IE.																						
										25ZLL005[P]	Position Indicator Low. Not valid as part of IE.																						
										25ZLH005[P]	Position Indicator High. Not valid as part of IE.																						
		2.2.3.2. Unable to achieve set point pressure for purge cycle. Unable to complete purge operation leading to a delay in start-up.																												15. Review the requirement for a timer alarm on the H2 pressurisation section of the purge cycle in the control logic to determine if the purge valve 25PV005 has failed to close.	Rosetti Instrumentation			
	2.2.4. 25XV006 Driven open/inadvertently opened by operator	2.2.4.1. Small increase in volume pulse purge, no hazardous consequences.								25ZLH006[X]	Position Indicator High																						
										25ZAL006[X]	Position Indicator Low alarm																						
	2.2.5. Spectacle Blind on Waste Water Line left open following maintenance	2.2.5.1. Potential overpressure of waste water tank T55001 due to N2 pressurisation resulting in overpressure and rupture of waste water tank T55001. Potential impact on personal. This is performed as part of the re commissioning check prior to introduction H2.	Release of Pressure - Impact	P	4	B	4B	N			None																			5. Review whether a permanent connection to the waste water tank T55001 is required from the hydrogen storage vessels. If so then review the potential for open waste water drain on storage vessel V25001A-F to result in overpressurisation of waste water tank during an N2 pressure test of the vessel following maintenance activity. Also consider the required vent sizing of waste water tank T55001 (to be calculated).	Rosetti Process			Recommendation eliminates cause (ALARP by design).
		2.2.5.2. H2 sent to Waste Water tank T55001 potential overpressure of waste water tank T55001 leading to LOPC of H2 and explosion on ignition. Not credible as this would imply N2 pressurisation has been carried out and consequence 1.2.5.1																															

Node: 2. Hydrogen (Purging)

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
		would have already occurred.																																
		2.2.5.3. Flammable atmosphere within waste water tank T55001 with potential for explosion on ignition. Not credible as this would imply N2 pressurisation has been carried out and consequence 1.2.5.1 would have already occurred.																																
	2.2.6. 25FIC001 failure opening 25FV001 N2 valve	2.2.6.1. Potential for N2 (7barg) into H2 storage vessel V25001A during purge operation resulting in off spec H2 sent to the Fuel Cell leading to operational issue no hazardous consequences as per Fuel Cell HAZOP (Cause 1.13.1).									No barriers within Rosetti scope, refer to Fuel cell HAZOP.																			16. Implement 25FV001 as a Type 6 as it is critical to the operation of the fuel cell that N2 is excluded from the storage system.	Rosetti Instrumentation			
	2.2.7. 25BDV022 Fails open/inadvertently opened by operator	2.2.7.1. H2 sent to H2 vent header and vented to atmosphere, loss of product. Potential for fire/explosion of continuously vented H2 at top of H2 vent. A single H2 storage vessel can be depressurised while maintaining pressure in the other vessels.	Hydrogen	P	5	A	5A	N		43FI001	High Flow indication on vent.																			1. Review the requirement for an alarm on 43FT001 and if required determine an appropriate set point to indicate continuous high pressure blowdown of H2 storage vessels.	Rosetti Process			
				A	4	B	4B			25PI004	Reducing Pressure indication in V25001A.																			2. Perform vent radiation and dispersion study to confirm that dispersion from continuous blowdown or fail open of: 1. 25PV005 of any single H2 storage vessel 2. 25XV003 (25RO003) 3. 25BDV005 (25RO005) 4. 80XV001 (80RO001) 5. 25BDV022 (25RO022) does not create a fire or explosion risk to the installation.	Rosetti Tech Safety			
				C	4	B	4B			25PT005	Reducing Pressure indication in V25001A																							
				E	3	B	3B			Classification and Hazardous Zoning	Area classification and hazardous area zoning to minimise ignition potential.																							
										25ZLL022[B]	Position Indicator Low. Not valid as part of IE.																							
										25ZAH022[B]	Position Indicator High alarm. Not valid as part of IE.																							
		2.2.7.2. Failure to purge downstream system of N2 and off spec H2 sent to the Fuel Cell leading to operational issue no hazardous consequences as per Fuel Cell HAZOP (Cause 1.13.1).																																
	2.2.8. 25PV025A/B remain open during purge	2.2.8.1. Slow purging of lines around PV, no hazardous consequences.								25ZLH025[F]	Position Transmitter																							
										25ZLL025[F]	Position Indicator Low																							
										25ZLH025[F]	Position Indicator High																							
	2.2.9. 80XV001 remains open at end of purge cycle	2.2.9.1. H2 sent to H2 vent header and vented to atmosphere, loss of product. Potential for fire/explosion of continuously vented H2 at top of H2 vent.	Hydrogen	P	5	A	5A	N		43FI001	High Flow indication on vent.																			1. Review the requirement for an alarm on 43FT001 and if required determine an appropriate set point to indicate continuous high pressure blowdown of H2 storage vessels.	Rosetti Process			Recommendation eliminates consequence (ALARP by design).
				A	4	B	4B			25PI004	Reducing Pressure indication in V25001A.																							

Node: 2. Hydrogen (Purging)

Deviation	Cause	Consequence	Hazard Register	RAM R	RAM S	RAM L	RAM RR	LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs EF Description	EFs EF Prob.	Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs CM Description	CMs CM Prob.	CMs Total CM PFD	Res. Risk. Freq.	Tolerable? Freq (/yr)	Tolerable? Y/N	Tolerable? Gap (RRF)	Recommendations	Recommendations Resp.	Recommendations PFD Improved	Res. Risk Freq. After Recs	ALARP Determination
		A single H2 storage vessel can be depressurised while maintaining pressure in the other vessels.		C	4	B	4B			25PT005	Reducing Pressure indication in V25001A																						
				E	3	B	3B			Classification and Hazardous Zoning	Area classification and hazardous area zoning to minimise ignition potential.																						
																													2. Perform vent radiation and dispersion study to confirm that dispersion from continuous blowdown or fail open of: 1. 25PV005 of any single H2 storage vessel 2. 25XV003 (25RO003) 3. 25BDV005 (25RO005) 4. 80XV001 (80RO001) 5. 25BDV022 (25RO022) does not create a fire or explosion risk to the installation.	Rosetti Tech Safety			
2.3. Flow Misdirected	2.3.1. 25XV008/11/14/17/20 open when not required and V25001B-F contains H2 at 5barg Consequence: 2.5.1.1	2.3.1.1. Additional H2 cycled into vessel under purge. Additional H2 is vented to atmosphere, loss of product. No hazardous consequences.																															
	2.3.2. 25XV008/11/14/17/20 open when not required and V25001B-F contains N2 at low pressure	2.3.2.1. Potential for N2 into H2 storage vessel V25001A under purge operation resulting in off spec H2 sent to the Fuel Cell leading to operational issue no hazardous consequences as per Fuel Cell HAZOP (Cause 1.13.1).									No barriers within Rosetti scope, refer to Fuel cell HAZOP.																		16. Implement 25FV001 as a Type 6 as it is critical to the operation of the fuel cell that N2 is excluded from the storage system.	Rosetti Instrumentation			
2.4. Flow As Well As	2.4.1. No additional causes.																																
2.5. Flow Reverse	2.5.1. 25XV008/11/14/17/20 open when not required and V25001B-F is at High pressure (30barg).	2.5.1.1. Refer to 2.3.1: Cause: 2.3.1																												14. Determine if high DP across any valves (likely to be up to 30bar) has the potential for high velocity (outside of pipe spec) or high vibration with the potential to damage pipework. If so consider how purging cycle can be performed without using SDV.	Rosetti Process			
	2.5.2. 25XV009/12/15/18/21 open when not required and V25001B-F is at High pressure (30barg).	2.5.2.1. Potential reverse flow from H2 storage vessels back to purge vessel which will also contain H2. No hazardous consequences.																															
2.6. Pressure Low	2.6.1. During purge cycle vessel pressure drops lower than intended (estimated 1.1barg)	2.6.1.1. Potential for air ingress from vent system and contamination of vent system								Liquid vent seal	Liquid seal on vent will prevent ingress into system.																						
										Nitrogen Purge on vent	Continuous N2 purge on vent system will prevent air ingress into system.																						
										25PI004	Pressure Indication																						
2.7. Pressure High	2.7.1. During purge cycle vessel pressure raised higher than intended (>5barg)	2.7.1.1. Excess H2 used for purge cycle, loss of product, no hazardous consequences.								25PI004	Pressure Indication																						
2.8. Temperature Low	2.8.1. Low ambient temperature	2.8.1.1. No hazardous consequences.																															

Node: 2. Hydrogen (Purging)

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
2.9. Temperature High	2.9.1. No additional causes.																																	
2.10. Level No/Low	2.10.1. No credible causes																																	
2.11. Level High	2.11.1. No credible causes																																	
2.12. Phase	2.12.1. No credible causes																																	
2.13. Composition/Contamination	2.13.1. See Node 1 Composition/Contamination																																	
	2.13.2. N2 contamination of storage vessel	2.13.2.1. Potential to contaminate H2 tank during purge cycle with no means of detecting contamination before use in Fuel Cell resulting in poor functioning of Fuel Cell. Operational issue, no hazardous consequences.																												17. Review the requirement for a separate header with an additional isolation on the N2 supply to the storage vessels to minimise the likelihood of N2 contamination of H2 storage vessels during purge cycle.	Rosetti Process			
2.14. Operations	2.14.1. Operating 25XV004 in pulse purge mode	2.14.1.1. Delta P across valve likely to be up to 30bar. Potential for high velocity (outside of pipe spec) or high vibration damaging pipework.																												14. Determine if high DP across any valves (likely to be up to 30bar) has the potential for high velocity (outside of pipe spec) or high vibration with the potential to damage pipework. If so consider how purging cycle can be performed without using SDV.	Rosetti Process			
2.15. Maintenance	2.15.1. N2 purging in preparation for maintenance	2.15.1.1. Unable to purge pipework between tee off for 25XV003 and Electrolyser. Potential for H2 to remain in pipework when broken for maintenance. Small LOPC of H2 likely to be insufficient to cause significant hazard.	Hydrogen	P A C E	5 4 4 3	A B B B	5A 4B 4B 3B	N		None Identified																				18. Review where a N2 purge connection can be located close to Electrolyser discharge to enable N2 purging of H2 storage inlet system.	Rosetti Process			Recommendation eliminates cause (ALARP by design).
	2.15.2. Fail closed of N2 valve 25FV001 when purging	2.15.2.1. Potential significant concentration H2 in vessel when breaking containment for maintenance.	Hydrogen	P A C E	5 4 4 3	A B B B	5A 4B 4B 3B			None Identified																				19. Review the requirement for a means to detect that the concentration of H2 within the H2 storage vessels is above the allowable level prior to breaking containment on the vessel.	Rosetti/Crosswind Project			Recommendation eliminates consequence (ALARP by design).
2.16. Start up/Shutdown	2.16.1. No additional causes.																																	
2.17. Catalysts	2.17.1. No credible causes																																	
2.18. Utilities	2.18.1. Loss of Power	2.18.1.1. See loss of Power in Node 1 Cause: 1.18.1																																
	2.18.2. Loss of Instrument Air	2.18.2.1. See loss of Instrument Air in Node 1 Cause: 1.18.2																																
	2.18.3. Loss of Nitrogen Supply	2.18.3.1. No hazardous consequences.																																
2.19. Corrosion/Erosion	2.19.1. No additional causes.																																	

Node: 2. Hydrogen (Purging)

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
2.20. Other																																		

Node: 3. Hydrogen (Electricity Production)

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
3.1. Flow No/Less	3.1.1. 25XV004 Fails closed	3.1.1.1. Normally closed during Fuel Cell operation. No hazardous consequences.																															
	3.1.2. BLPH-MV-029 DBB Left in closed position on Vessel inlet stream	3.1.2.1. Not credible during Fuel Cell operation.																															
	3.1.3. Spectacle Blind on Inlet Stream	3.1.3.1. Not credible during Fuel Cell operation.																															
	3.1.4. BLPH-MV-032 DBB Left in closed position on Hydrogen Vent	3.1.4.1. Loss of safeguard for pressure relief.								LO Valve	BLPH-MV-032 is a LO valve																							
	3.1.5. BLPH-MV-034 DBB Left in closed position on Blowdown System	3.1.5.1. Not credible during Fuel Cell operation.																															
	3.1.6. 25PV005 Fails closed	3.1.6.1. Normally closed during Fuel Cell operation. No hazardous consequences.																															
	3.1.7. 25BDV005 Fails closed on Blowdown Stream	3.1.7.1. Normally closed during Fuel Cell operation. No hazardous consequences.																															
	3.1.8. Spectacle Blind on Discharge Line	3.1.8.1. Unable to line up vessel for Fuel Cell operation leading to delay in operation, no hazardous consequences.																															
	3.1.9. BLPH-MV-086 DBB Left in closed position on Discharge Line	3.1.9.1. Unable to line up vessel for Fuel Cell operation leading to delay in operation, no hazardous consequences.																															
	3.1.10. 25XV006 Failed closed on Discharge Line	3.1.10.1. Unable to line up vessel for Fuel Cell operation leading to delay in operation, no hazardous consequences.								25ZAL006[X]	Position Indicator Low alarm																							
										25ZLH006[X]	Position Indicator High																							
	3.1.11. Spectacle Blind on Waste Water Line	3.1.11.1. Normally closed during Fuel Cell operation.																															
	3.1.12. 25FV001 N2 valve	3.1.12.1. Normally closed during Fuel Cell operation.																															
	3.1.13. BLPH-MV-088 DBB Left in	3.1.13.1. Not credible during Fuel Cell operation.																															

Node: 3. Hydrogen (Electricity Production)

Deviation	Cause	Consequence	Hazard Register	RAM R	RAM S	RAM L	RAM RR	LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs EF Description	EFs EF Prob.	Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs CM Description	CMs CM Prob.	CMs Total CM PFD	Res. Risk. Freq.	Tolerable? Freq (/yr)	Tolerable? Y/N	Tolerable? Gap (RRF)	Recommendations	Recommendations Resp.	Recommendations PFD Improved	Res. Risk Freq. After Recs	ALARP Determination
	closed position on N2 Line																																
	3.1.14. Spectacle Blind on N2 Line	3.1.14.1. Not credible during Fuel Cell operation.																															
	3.1.15. 25SDV023 Fails closed	3.1.15.1. Unable to line up vessel for Fuel Cell operation leading to delay in operation, no hazardous consequences.								25ZLH023[S]	Position Indicator High																							
										25ZAL023[S]	Position Indicator Low alarm																						
	3.1.16. 25PIC025A/B fails closing 25PV025A/B	3.1.16.1. Unable to line up vessel for Fuel Cell operation leading to delay in operation, no hazardous consequences.								25ZLH025[P]	Position Transmitter. Not valid as part of IE.																						
										25ZLL025[P]	Position Indicator Low. Not valid as part of IE.																						
										25ZLH025[P]	Position Indicator High. Not valid as part of IE.																						
	3.1.17. BLPH-MV-492 SB Left in closed position on Downstream line	3.1.17.1. Upstream: Potential overpressure of pipework downstream of 25PV025A/B. LOPC of H2 and potential explosion on ignition. Not included in recommendation 21/22 for LOPA as the likelihood of this cause will not be significant.	Hydrogen	P	5	A	5A	Y		25PIC025A/B	High Pressure alarm. Not valid as insufficient time for operator action.	NV			80PI002	Human Error Probability (with procedure, without checklist): HEP * number of critical steps * opportunities /yr 3E-03*1*2. First restart after error will result in event.	6.0E-03	Unmanned platform, will be visited 1%/year, 10% assumed.	1.0E-01	6.0E-04	1.0E-02	6.0E-06				6.0E-06	1.0E-04	Y		20. Ensure that 80PSV001 is verified for blocked discharge downstream of 25PV025A/B during fuel cell operation. No consideration is made of advantageous control from 25PCV025A/B as per Shell rule set.	Rosetti Process			PHA Team considers this scenario to be ALARP and that adding additional barriers would be grossly disproportionate to the risk reduction achieved. Additional barriers considered: //
				A	4	B	4B			80PI002	High High Pressure trip of PSD closing 25SDV023.	NV	SIL to be determined	1.0E+00												1.0E-03	Y						
				C	4	B	4B			80PSV001	Pressure Safety Valve set point at 10barg. Valid, to be sized for this case as per recommendation.	NV	RV or Vacuum Breaker (fail mode:fail to open) (Table 2#25 no Clean service reduction as Control of Personnel CM used)	1.0E-02												1.0E-03	Y						
				E	3	B	3B																				1.0E-02	Y						
	3.1.18. Blockage in line within Fuel Cell Package, considered to be failure to reopen main isolation valve following maintenance.	3.1.18.1. Upstream: Potential overpressure of pipework downstream of 25PV025A/B. LOPC of H2 and potential explosion on ignition.	Hydrogen	P	5	A	5A	Y		25PIC025A/B	High Pressure alarm. Not valid as insufficient time for operator action.	NV			80PI002	Human Error Probability (with procedure, without checklist): HEP * number of critical steps * opportunities /yr 3E-03*1*2. First restart after error will result in event.	6.0E-03	Unmanned platform, will be visited 1%/year, 10% assumed.	1.0E-01	6.0E-04	1.0E-02	6.0E-06				6.0E-06	1.0E-04	Y		20. Ensure that 80PSV001 is verified for blocked discharge downstream of 25PV025A/B during fuel cell operation. No consideration is made of advantageous control from 25PCV025A/B as per Shell rule set.	Rosetti Process			PHA Team considers this scenario to be ALARP and that adding additional barriers would be grossly disproportionate to the risk reduction achieved. Additional barriers considered: //
				A	4	B	4B			80PI002	High High Pressure trip of PSD closing 25SDV023.	NV	SIL to be determined	1.0E+00												1.0E-03	Y		21. Review the required response time (PST) of 80PI002/25SDV023 to ensure that they are able to react to prevent exceedance of hydrotest pressure of the downstream pipework and Fuel Cell if 25PCV025A/B are fully opened.	Rosetti/Crosswind (Interface)			
				C	4	B	4B			80PSV001	Pressure Safety Valve set point at 10barg. Valid, to be sized for this case as per recommendation.	V	RV or Vacuum Breaker (fail mode:fail to open) (Table 2#25 no Clean service reduction as Control of Personnel CM used)	1.0E-02												1.0E-03	Y		22. Review the required response time (PST) of 80PSV001 to ensure that it is able to react and depressurise the system quickly enough to prevent overpressure of the pipework and Fuel Cell if 25PCV025A/B are fully opened. Consider the opening times of storage vessels outlet XVs, e.g. 25XV006 and 25PV025A/B. If PSV reaction time criteria cannot be met LOPA for 25PI002 must be reviewed.	Rosetti/Crosswind (Interface)			
				E	3	B	3B																				1.0E-02	Y						

Node: 3. Hydrogen (Electricity Production)

Deviation	Cause	Consequence	Hazard Register	RAM R	RAM S	RAM L	RAM RR	LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs EF Description	EFs EF Prob.	Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs CM Description	CMs CM Prob.	CMs Total CM PFD	Res. Risk. Freq.	Tolerable? Freq (/yr)	Tolerable? Y/N	Tolerable? Gap (RRF)	Recommendations	Recommendations Resp.	Recommendations PFD Improved	Res. Risk Freq. After Recs	ALARP Determination
		3.1.18.2.																															
	3.1.19. BLPH-MV-006 SB Left in closed position on Downstream relief line	3.1.19.1. Loss of safeguard for pressure relief.								LO Valve	BLPH-MV-032 is a LO valve																							
3.2. Flow More	3.2.1. 25PIC005 failure opening 25PV005	3.2.1.1. H2 sent to H2 vent header and vented to atmosphere, loss of product. Potential for fire/explosion of continuously vented H2 at top of H2 vent. A single H2 storage vessel can be depressurised while maintaining pressure in the other vessels.	Hydrogen	P	5	A	5A	N		43FI001	High Flow indication on vent.																			1. Review the requirement for an alarm on 43FT001 and if required determine an appropriate set point to indicate continuous high pressure blowdown of H2 storage vessels.	Rosetti Process			Recommendation eliminates consequence (ALARP by design).
				A	4	B	4B			25PI004	Reducing Pressure indication in V25001A.																			2. Perform vent radiation and dispersion study to confirm that dispersion from continuous blowdown or fail open of: 1. 25PV005 of any single H2 storage vessel 2. 25XV003 (25RO003) 3. 25BDV005 (25RO005) 4. 80XV001 (80RO001) 5. 25BDV022 (25RO022) does not create a fire or explosion risk to the installation.	Rosetti Tech Safety			
				C	4	B	4B			25PT005	Reducing Pressure indication in V25001A																			3. Review if it is credible to implement an interlock on 25PIC005 to prevent 25PV005 being opened outside of a purge cycle operation.	Rosetti Process			
				E	3	B	3B			Classification and Hazardous Zoning	Area classification and hazardous area zoning to minimise ignition potential.																						
										25ZLH005[P]	Position Transmitter. Not valid as part of IE.																						
										25ZLL005[P]	Position Indicator Low. Not valid as part of IE.																						
										25ZLH005[P]	Position Indicator High. Not valid as part of IE.																						
	3.2.2. 25FIC001 failure opening 25FV001 N2 valve	3.2.2.1. Potential for N2 (7barg) into H2 storage vessel V25001A at end of Fuel Cell operation resulting in off spec H2 sent to the Fuel Cell leading to operational issue no hazardous consequences as per Fuel Cell HAZOP (Cause 1.13.1).									No barriers within Rosetti scope, refer to Fuel cell HAZOP.																		6. Review if it is credible to implement an interlock to prevent 25FV001 being opened outside of a purge cycle operation.	Rosetti Process			
																											17. Review the requirement for a separate header with an additional isolation on the N2 supply to the storage vessels to minimise the likelihood of N2 contamination of H2 storage vessels during purge cycle.	Rosetti Process			
		3.2.2.2. Potential for H2 (up to 30barg) into N2 system resulting in H2 being used in place of N2 in Electrolyser systems. Refer to Elogen HAZOP node 10.																															
		3.2.2.3. Overpressure of N2 system resulting in LOPC of H2 and N2.	Hydrogen	P	5	A	5A	N		BLPH-NRV-014	Non-return valve.																			7. Review the current design against for compliance with piping (utility connection DEP 31.38.01.11, version 2018) and overpressure (80.45.10.11) DEPs for connection of utility N2 to H2 storage vessels	Rosetti Process			To be determined / re-evaluated after closeout of recommendation.

Node: 3. Hydrogen (Electricity Production)

Deviation	Cause	Consequence	Hazard Register	RAM R	RAM S	RAM L	RAM RR	LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs EF Description	EFs EF Prob.	Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs CM Description	CMs CM Prob.	CMs Total CM PFD	Res. Risk. Freq.	Tolerable? Freq (/yr)	Tolerable? Y/N	Tolerable? Gap (RRF)	Recommendations	Recommendations Resp.	Recommendations PFD Improved	Res. Risk Freq. After Recs	ALARP Determination
																														V25001A-F. If they are not compliant (and are not to be made compliant) review current design with LOPA.				
				A	4	B	4B			64PIC001A	High Pressure alarm with operator action. Not valid as insufficient time.																		8. Ensure that 64PSV001 is verified for backflow of 30 barg H2 from storage vessels V25001A-F. Ensure that the vent from PSV is located in a safe location considering this flow will be H2. Also consider proximity of vent to N2 package which vents O2.	Rosetti Process			
				C	4	B	4B			64PIC001B	High Pressure alarm with operator action. Not valid as insufficient time.																						
				E	3	B	3B			64PSV001	Pressure Safety Valve set point at 10barg.																						
										25ZLH005[F]	Position Transmitter. Not valid as part of IE.																						
										25ZLL005[F]	Position Indicator Low. Not valid as part of IE.																						
										25ZLH005[F]	Position Indicator High. Not valid as part of IE.																						
		3.2.2.4. H2 reverse flow into N2 package U64000. Review consequences within HAZOP of N2 package. [Parking Lot; What: N2 package HAZOP]																															
	3.2.3. 25BDV022 Fails open/inadvertently opened by operator	3.2.3.1. H2 sent to H2 vent header and vented to atmosphere, loss of product. Potential for fire/explosion of continuously vented H2 at top of H2 vent. A single H2 storage vessel can be depressurised while maintaining pressure in the other vessels.	Hydrogen	P	5	A	5A	N		43FI001	High Flow indication on vent.																				1. Review the requirement for an alarm on 43FT001 and if required determine an appropriate set point to indicate continuous high pressure blowdown of H2 storage vessels.	Rosetti Process			Recommendation eliminates consequence (ALARP by design).
				A	4	B	4B			25PI004	Reducing Pressure indication in V25001A.																		2. Perform vent radiation and dispersion study to confirm that dispersion from continuous blowdown or fail open of: 1. 25PV005 of any single H2 storage vessel 2. 25XV003 (25RO003) 3. 25BDV005 (25RO005) 4. 80XV001 (80RO001) 5. 25BDV022 (25RO022) does not create a fire or explosion risk to the installation.	Rosetti Tech Safety			
				C	4	B	4B			25PT005	Reducing Pressure indication in V25001A																						
				E	3	B	3B			Classification and Hazardous Zoning	Area classification and hazardous area zoning to minimise ignition potential.																						
										25ZLL022[B]	Position Indicator Low. Not valid as part of IE.																						
										25ZAH022[B]	Position Indicator High alarm. Not valid as part of IE.																						
	3.2.4. 25PV025A and B both in operation	3.2.4.1. Both under downstream pressure control, no significant impact. No hazardous consequences.								25HS025	HS includes software interlock to prevent both valves to be online simultaneously.																						
	3.2.5. 25PIC025A/B control failure opening 25PV025A/B	3.2.5.1. Potential overpressure of pipework downstream of 25PV025A/B. LOPC of H2 and potential explosion on ignition.	Hydrogen	P	5	A	5A	Y		25PIC025A/B	High Pressure alarm. Not valid as insufficient time for operator action also part of IE.	NV			80PI002	Control Loop (Electronic): Fails to danger	1.0E-01	Fuel cell in use = 135 starts/yr * 8hrs duration = 1000hrs/yr. This is roughly 10% of the time.	1.0E-01	1.0E-03	1.0E-02	1.0E-05				1.0E-05	1.0E-04	Y	21. Review the required response time (PST) of 80PI002/25SDV023 to ensure that they are able to react to prevent exceedance of hydrotest pressure of the downstream pipework and Fuel Cell if 25PCV025A/B are fully opened.	Rosetti/Crosswind (Interface)			PHA Team considers this scenario, after implementation of recommendations, to be ALARP and that adding additional barriers would be grossly disproportionate to the risk reduction achieved. Additional barriers considered: 25PI002/25SDV003 at SIL 1
				A	4	B	4B			80PI002	High High Pressure trip of PSD closing 25SDV023.	NV	SIL to be determined	1.0E+00			Unmanned platform, will be visited 1%/year, 10% assumed.	1.0E-01								1.0E-03	Y	22. Review the required response time (PST) of 80PSV001 to ensure that it is able to react and depressurise the system quickly enough to prevent overpressure of the pipework and Fuel Cell if 25PCV025A/B are fully opened.	Rosetti/Crosswind (Interface)			
				C	4	B	4B			80PSV001	Pressure Safety Valve set point at 10barg. Valid, to be sized for this case as per recommendation.	V	RV or Vacuum Breaker (fail mode:fail to open) (Table 2#25 no Clean service reduction as	1.0E-02													1.0E-03	Y					

Node: 3. Hydrogen (Electricity Production)

Deviation	Cause	Consequence	Hazard Register	RAM	LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
															EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
										Control of Personnel CM used)																						
				E 3 B 3B			25ZLH025[P]	Position Transmitter. Not valid as part of IE.	NV															1.0E-02	Y		Consider the opening times of storage vessels outlet XVs, e.g. 25XV006 and 25PV025A/B. If PSV reaction time criteria cannot be met LOPA for 25PI002 must be reviewed.					
							25ZLL025[P]	Position Indicator Low. Not valid as part of IE.	NV																						
							25ZLH025[P]	Position Indicator High. Not valid as part of IE.	NV																						
	3.2.6. 80XV001 Fails open	3.2.6.1. H2 sent to H2 vent header and vented to atmosphere, loss of product. Potential for fire/explosion of continuously vented H2 at top of H2 vent. A single H2 storage vessel can be depressurised while maintaining pressure in the other vessels.	Hydrogen	P 5 A 5A	N		43FI001	High Flow indication on vent.																			1. Review the requirement for an alarm on 43FT001 and if required determine an appropriate set point to indicate continuous high pressure blowdown of H2 storage vessels.	Rosetti Process			Recommendation eliminates consequence (ALARP by design).
				A 4 B 4B			25PI004	Reducing Pressure indication in V25001A.																			2. Perform vent radiation and dispersion study to confirm that dispersion from continuous blowdown or fail open of: 1. 25PV005 of any single H2 storage vessel 2. 25XV003 (25RO003) 3. 25BDV005 (25RO005) 4. 80XV001 (80RO001) 5. 25BDV022 (25RO022) does not create a fire or explosion risk to the installation.	Rosetti Tech Safety			
				C 4 B 4B			25PT005	Reducing Pressure indication in V25001A																							
				E 3 B 3B			Classification and Hazardous Zoning	Area classification and hazardous area zoning to minimise ignition potential.																							
							80ZAH001[X]	Position Indicator High																							
							80ZLL001[X]	Position Indicator Low																							
3.3. Flow Misdirected	3.3.1. 25XV004 Open during Fuel Cell Operation	3.3.1.1. On cold stand-by Electrolyser depressurises and vents contents of H2 Storage vessel to Electrolyser vent stack. Operational issue, loss of product, no hazardous consequence.					Elogen PV633	On cold stand-by PV633 on discharge of Electrolyser system is close.																							
							Elogen NRV CV633	Non return valve within discharge of Electrolyser system.																							
							25ZLH004[X]	Position Indicator High																							
							25ZAL004[X]	Position Indicator Low alarm																							
		3.3.1.2. On hot stand-by Electrolyser maintains 30barg. Small potential for gas movement within H2 storage inlet header. No hazardous consequence.					25ZLH004[X]	Position Indicator High																							
							25ZAL004[X]	Position Indicator Low alarm																							
	3.3.2. 25XV009/12/15/18/21 open when not required and V25001B-F is at Low pressure H2.	3.3.2.1. Rapid increase in Pressure in vessels V25001B-F from 0 to 30barg. Potential for exceeding design velocity or high vibration in piping and vessels V25001B-F leading to potential LOPC of H2.	Hydrogen	P 5 A 5A	N		None Identified																			14. Determine if high DP across any valves (likely to be up to 30bar) has the potential for high velocity (outside of pipe spec) or high vibration with the potential to damage pipework. If so consider how purging cycle can be performed without using SDV.	Rosetti Process			Recommendation eliminates consequence (ALARP by design).
				A 4 B 4B																											
				C 4 B 4B																											
				E 3 B 3B																											
	3.3.3. 25XV009/12/15/18/21 open when not required and V25001B-F is at Low pressure N2.	3.3.3.1. Rapid increase in Pressure in vessels V25001B-F from 0 to 30barg. Potential for exceeding design velocity or high vibration in piping and vessels V25001B-F leading to potential LOPC of H2.	Hydrogen	P 5 A 5A	N		None Identified																			14. Determine if high DP across any valves (likely to be up to 30bar) has the potential for high velocity (outside of pipe spec) or high vibration with the potential to damage pipework. If so consider how purging cycle can be performed without using SDV.	Rosetti Process			Recommendation eliminates consequence (ALARP by design).
				A 4 B 4B																											
				C 4 B 4B																											
				E 3 B 3B																											

Node: 3. Hydrogen (Electricity Production)

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
		3.3.3.2. Contamination of Feed stream to Fuel Cell and off spec H2 sent to the Fuel Cell leading to operational issue no hazardous consequences as per Fuel Cell HAZOP (Cause 1.13.1).																																
	3.3.4. 25XV009/12/15/18/21 open when not required and V25001B-F is at High pressure (30barg).	3.3.4.1. No hazardous consequences.																																
3.4. Flow As Well As	3.4.1. No additional causes.																																	
3.5. Flow Reverse	3.5.1. No additional causes.																																	
3.6. Pressure Low	3.6.1. Low Pressure at inlet to Fuel Cell	3.6.1.1. Potential damage of Fuel Cell and loss of Power generation. Operational issue, no hazardous consequences. Low pressure likely to occur during normal operation when storage tank is depleted.								25PIC025A/B	Low Pressure indication (No alarm)																				23. Review the requirement for a low pressure alarm on 25PIC025A/B to indicate that the PCV no longer has control over the downstream pressure due to depletion (low pressure) of the H2 storage vessel and low low pressure trip on 80PI002 to shutdown the Fuel Cell Package.	Rosetti Process			
										80PI002	Low Pressure indication (No alarm)																					
3.7. Pressure High	3.7.1. External Fire	3.7.1.1. Refer to Node 1 External Fire. Cause: 1.7.1																																
3.8. Temperature Low	3.8.1. Low ambient temperature	3.8.1.1. No hazardous consequences.																																
3.9. Temperature High	3.9.1. No additional causes.																																	
3.10. Level No/Low	3.10.1. No credible causes																																	
3.11. Level High	3.11.1. No credible causes																																	
3.12. Phase	3.12.1. No credible causes																																	
3.13. Composition/Contamination	3.13.1. Moisture due to failure of HPP	3.13.1.1. Potential for moisture from the Electrolyser (failed HPP) to be sent through the storage system (where there is no moisture detection) to the Fuel Cell. Potential loss of performance in Fuel Cell, operational issue. No hazardous consequences.								Fuel Cell Performance	Loss of Performance within Fuel Cell will be detected and Feed stream can be vented to remove contaminated H2.																					
										Elogen DPT800A/B	Dew Point Analysers divert H2 stream to vent if above moisture specification within Elogen Package.																					
3.14. Operations	3.14.1. No additional causes.																																	
3.15. Maintenance	3.15.1. No additional causes.																																	
3.16. Start up/ Shutdown		3.16.1.1. Potential for overpressurisation of line and Fuel Cell	Hydrogen	P	5	A	5A	Y		80PI002	High High Pressure trip of PSD closing 25SDV023. Potentially insufficient time to prevent rupture of pipework or Fuel Cell,	NV	This is the normal start-up protective system			Normal Start-up of Power	1.4E+02	Unmanned platform, will be visited	1.0E-01	1.4E+01		1.4E+01				1.4E+01	1.0E-04	N	135000	46. As fuel cell runs down 25PIC025A/B opens 25PV025A/B. Ensure that when				

Node: 3. Hydrogen (Electricity Production)

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
	3.16.1. Start up of Fuel Cell 135 times/year	downstream of 25PCV025A/B due to reaction speed of 25PIC025A/B. Insufficient time for control system to react to prevent downstream overpressure. Assumption is that as fuel cell runs down 25PIC025A/B opens 25PV025A/B such that when restart occurs 25PV025A/B are fully open.									however likely to be able to prevent large LOPC from loss of H2 vessel inventory. Review in Interface HAZOP for Rosetti/Fuel Cell [Parking Lot; What: Review in Interface HAZOP for Rosetti/Fuel Cell]		should not be in used for this event.			generation this 135 per year		1%/year, 10% assumed.											restart occurs 25PV025A/B are fully closed and review how the downstream pressure can be slowly increased to the point where 25PIC025A/B can be given automatic control.	Rosetti Instrumentation			Recommendation eliminates consequence (ALARP by design).
				A	4	B	4B			80PSV001	Pressure Safety Valve. May not be valid as potential insufficient time for spring operated PSV to react due to volumes in line. Review in Interface HAZOP for Rosetti/Fuel Cell [Parking Lot; What: Review in Interface HAZOP for Rosetti/Fuel Cell]	NV	This is the normal start-up protective system should not be in used for this event.													1.0E-03	N	13500						
				C	4	B	4B																					1.0E-03	N	13500						
				E	3	B	3B																					1.0E-02	N	1350						
3.17. Catalysts	3.17.1. No credible causes																																	
3.18. Utilities	3.18.1. Loss of Power	3.18.1.1. Refer to Node 1. Cause: 1.18.1																																
	3.18.2. Loss of Instrument Air	3.18.2.1. Section of line between 25SDV001 and 25XV004 will be blocked in during ESD scenario.																												11. Ensure that the trapped volume between 25SVD023 and 25PV025A/B is minimised such that it does not require blowdown.	Rosetti Process				
																														12. Review the trapped volume between Fuel Cell Package and 25PV025A/B is minimised such that it does not require blowdown or consider providing a blowdown route. See also recommendation 10.	Rosetti Process				
		3.18.2.2. 25XV006 Fails closed leading to low pressure of H2 to Fuel Cell when Fuel Cell is in operation, refer to Fuel Cell HAZOP. [Parking Lot; What: Review with Fuel Cell HAZOP]																																
	3.18.3. Loss of Nitrogen Supply	3.18.3.1. No hazardous consequences.																																
3.19. Corrosion/ Erosion	3.19.1. No additional causes.																																	
3.20. Other	3.20.1. No additional causes.																																	

Node: 4. Hydrogen Vent System

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
4.1. Flow No/Less	4.1.1. BLPH-MV-002 SB Left in closed position	4.1.1.1. Upstream: No flow from Electrolyser Package into H2 vent. Blocked outlet on Electrolyser relief and vent systems. Review in Elogen HAZOP. [Parking Lot; What: Review in Elogen HAZOP.]								LO Valve	BLPH-MV-002 is a LO valve.																			32. Review the requirement for BLPH-MV-002 in the H2 vent system as this is a potential isolation point within a relief route. Also review the piping specification around the tie in point and identify it on P&ID to ensure compatibility.	Rosetti Process				
		4.1.1.2. Downstream: No hazardous consequences.																																
	4.1.2. 25XV003 fails closed on Hydrogen vent line	4.1.2.1. Upstream: Refer to 2.1.5: Cause: 2.1.5																																
		4.1.2.2. Downstream: No hazardous consequences.																																
	4.1.3. BLPH-MV-212 DBB Left in closed position	4.1.3.1. Upstream: Refer to 2.1.5: Cause: 2.1.5								LO Valve	BLPH-MV-212 is a LO valve.																							
		4.1.3.2. Downstream: No hazardous consequences.																																
	4.1.4. BLPH-MV-033 DBB Left in closed position	4.1.4.1. Upstream: Unable to relieve vessel V-25001A when required. Potential escalation of existing incident or unable to prepare installation for maintenance.								LO Valve	BLPH-MV-033 is a LO valve.																			33. Review the location of the spec break downstream of: 1. 25PSV001A/BLPH-MV-033 2. 80PSV001/BLPH-MV-005 As pipework between PSV and manual valve will see upstream pressure if closed and a relief occurs.	Rosetti Process				
		4.1.4.2. Downstream: No hazardous consequences.																																
	4.1.5. 25PV005 Fails closed	4.1.5.1. Upstream: Refer to 2.1.11: Cause: 2.1.11																																
		4.1.5.2. Downstream: No hazardous consequences.																																
	4.1.6. 25BDV005 Fails closed on Blowdown Stream	4.1.6.1. Upstream: Unable blowdown vessel V-25001A when required. Potential escalation of existing incident or unable to prepare installation for maintenance.								25ZAH022[B]	Position Indicator alarm high																							
		4.1.6.2. Downstream: No hazardous consequences.																																
	4.1.7. BLPH-MV-035 DBB Left in closed position on V-25001A relief	4.1.7.1. Upstream: Refer to 4.1.5.1								LO Valve	BLPH-MV-035 is a LO valve.																							
		4.1.7.2. Downstream: No hazardous consequences.																																

Node: 4. Hydrogen Vent System

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
	4.1.8. 25BDV022 fails closed	4.1.8.1. Upstream: Unable blowdown discharge manifold of H2 storage vessels when required. Potential escalation of existing incident or unable to prepare installation for maintenance.								25ZAH022[B]	Position Indicator alarm high																							
		4.1.8.2. Downstream: No hazardous consequences.																															
	4.1.9. BLPH-MV-019 DBB Left in closed position on V-25001A relief	4.1.9.1. Upstream: Refer to 4.1.7.1								LO Valve	BLPH-MV-019 is a LO valve.																							
		4.1.9.2. Downstream: No hazardous consequences.																															
	4.1.10. BLPH-MV-005 DBB Left in closed position	4.1.10.1. Upstream: Unable to relieve when required. Potential escalation of existing incident or unable to prepare installation for maintenance.								LO Valve	BLPH-MV-005 is a LO valve.																				33. Review the location of the spec break downstream of: 1. 25PSV001A/BLPH-MV-033 2. 80PSV001/BLPH-MV-005 As pipework between PSV and manual valve will see upstream pressure if closed and a relief occurs.	Rosetti Process			
		4.1.10.2. Downstream: No hazardous consequences.																															
	4.1.11. No flow from N2 package to H2 vent Consequence: 4.18.2.1	4.1.11.1. Upstream: no impact on N2 system.																															
		4.1.11.2. Downstream: Potential for air to be drawn into system via vent stack resulting in a flammable mixture within the vent system. Potential explosion upon ignition in vent system.	Hydrogen	P	5	A	5A	N		64PI001A/B	Low Pressure alarm on N2 system																			34. Review the requirement for level transmitter and low level alarm to detect low level in H2 vent liquid seal Q43004.	Rosetti Instrumentation			PHA Team considers this scenario, after implementation of recommendations, to be ALARP and that adding additional barriers would be grossly disproportionate to the risk reduction achieved. Additional barriers considered: Automatic level control not implemented due to increased complexity.
				A	4	B	4B			64PI002	Low Low Pressure alarm on N2 system will activate ESD 1D																							
				C	4	B	4B			Liquid vent seal	Liquid seal on vent will prevent ingress into system.																							
				E	3	B	3B			Ignition Sources	No ignition sources within H2 vent system. Static ignition sources suppressed with Earth bonding.																							
	4.1.12. BLPH-MV-171 Left in closed position on N2 system	4.1.12.1. Upstream: no impact on N2 system.																															
		4.1.12.2. Downstream: Potential for air to be drawn into system via vent stack resulting in a flammable mixture within the vent system. Potential explosion upon ignition in vent system.	Hydrogen	P	5	A	5A	N		Liquid vent seal	Liquid seal on vent will prevent ingress into system.																			34. Review the requirement for level transmitter and low level alarm to detect low level in H2 vent liquid seal Q43004.	Rosetti Instrumentation			PHA Team considers this scenario, after implementation of recommendations, to be ALARP and that adding additional barriers would be grossly disproportionate to the risk reduction achieved. Additional barriers considered: Automatic level control not implemented due to increased complexity.
				A	4	B	4B			Ignition Sources	No ignition sources within H2 vent system. Static ignition sources suppressed with Earth bonding.																							
				C	4	B	4B			Commissioning Checks	Flow through BLPH-MV-171 set up using flow meter 64FG001 during commissioning.																							
				E	3	B	3B																											
	4.1.13. BLPH-MV-172 Left in closed position on N2 system	4.1.13.1. Upstream: no impact on N2 system.																															
		4.1.13.2. Downstream: Potential for air to be drawn into system via vent stack resulting in a flammable mixture within the vent system. Potential	Hydrogen	P	5	A	5A	N		Liquid vent seal	Liquid seal on vent will prevent ingress into system.																			34. Review the requirement for level transmitter and low level alarm to detect low level in H2 vent liquid seal Q43004.	Rosetti Instrumentation			PHA Team considers this scenario, after implementation of recommendations, to be ALARP and that adding additional barriers would be grossly disproportionate to the risk
				A	4	B	4B			Ignition Sources	No ignition sources within H2 vent system. Static ignition sources suppressed with Earth bonding.																							

Node: 4. Hydrogen Vent System

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
		explosion upon ignition in vent system.		C	4	B	4B			Commissioning Checks	Flow through BLPH-MV-171 set up using flow meter 64FG001 during commissioning.																							reduction achieved. Additional barriers considered: Automatic level control not implemented due to increased complexity.
				E	3	B	3B			LO Valve	BLPH-MV-172 is a LO valve.																						
	4.1.14. BLPH-MV-409 SB Left in closed position on V-43001 drain	4.1.14.1. Upstream: Unable to drain liquid from KO Drum V-43001 leading to potential high level in KO Drum and liquid into H2 relief header resulting in high back pressure to relieving streams. Rupture of relief streams, LOPC of H2 and explosion on ignition. 90 Electrolyser starts/yr, 0.5 hr/start-up, 3.2kg/hr of water(worst credible scenario based on condensation of all water in stream), Platform visited for maintenance 2 times/yr where issue can be identified and rectified. 0.076 m3 of water within 2m3 KO drum overfill of vessel not considered credible.									43LIC001	High level alarm with sufficient time to stop production.	V	Operator intervention - Single alarm plus operator response	1.0E-01		Human Error Probability (with procedure, without checklist): HEP * number of critical steps * opportunities /yr 3E-03*1*2. First restart after error will result in event.	6.0E-03					**Control of Personnel** - procedural assurance required Unmanned platform, will be visited 1%/year, 10% assumed.	1.E-01	1.0E-01					47. Review the requirement for 43LI002 High High activating ESD 1 as no scenarios were identified within the HAZOP which would activate the trip. Verify before removal that there is no requirement from project applicable standards and good practice (DEP) for this trip.	Rosetti Process			
										43LI002	High high level trip activating ESD 1.	V	SIL to be determined	1.0E+00																		
										43PI001	High pressure alarm, not valid as insufficient time to react.	NV																				
	4.1.15. 43LIC001 control loop failure closing 43LV001	4.1.15.1. Upstream: Unable to drain liquid from KO Drum V-43001 leading to potential high level in KO Drum and liquid into H2 relief header resulting in high back pressure to relieving streams. Rupture of relief streams, LOPC of H2 and explosion on ignition. 90 Electrolyser starts/yr, 0.5 hr/start-up, 3.2kg/hr of water(worst credible scenario based on condensation of all water in stream), Platform visited for maintenance 2 times/yr where issue can be identified and rectified. 0.076 m3 of water within 2m3 KO drum overfill of vessel not considered credible.									43LIC001	High level alarm, not valid as part of IE.	V				Control Loop (Electronic): Fails to danger	1.0E-01					**Control of Personnel** - procedural assurance required Unmanned platform, will be visited 1%/year, 10% assumed.	1.E-01	1.0E-01					47. Review the requirement for 43LI002 High High activating ESD 1 as no scenarios were identified within the HAZOP which would activate the trip. Verify before removal that there is no requirement from project applicable standards and good practice (DEP) for this trip.	Rosetti Process			
										43LI002	High high level trip activating ESD 1.	V	SIL to be determined	1.0E+00																		
										43PI001	High pressure alarm, not valid as insufficient time to react.	NV																				
4.2. Flow More	4.2.1. Full production rate of H2 from Elogen Electrolyser sent to vent	4.2.1.1. Full production of wet H2 sent to H2 vent. Potential high back pressure on other vent users and high moisture content of stream. No hazardous consequences as this is the design case for the vent system.																												29. Determine the back pressure on the vent system for full wet production H2 sent to H2 vent. Determine the effects of high back pressure on other vent users, consider the effect on relief valve set points and Electrolyser Oxygen in Hydrogen analysers due to back pressure. Review impacts with interface units. See also recommendation 31	Crosswind			

Node: 4. Hydrogen Vent System

Deviation	Cause	Consequence	Hazard Register	RAM R	RAM S	RAM L	RAM RR	LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs EF Description	EFs EF Prob.	Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs CM Description	CMs CM Prob.	CMs Total CM PFD	Res. Risk. Freq.	Tolerable? Freq (/yr)	Tolerable? Y/N	Tolerable? Gap (RRF)	Recommendations	Recommendations Resp.	Recommendations PFD Improved	Res. Risk Freq. After Recs	ALARP Determination
	4.2.2. Pressure venting from Elogen Electrolyser pressure control	4.2.2.1. Intermittent flow significantly less then full production, no significant impact. No hazardous consequences.																																
	4.2.3. Flow from Elogen Electrolyser sample system	4.2.3.1. Very small continuous flow, no significant impact. No hazardous consequences.																											31. Review the impact of back pressure in the H2 vent system on the Elogen product sample system. Consider that the Electrolyser may be in start-up and venting wet H2 and this is the critical time for sampling of the product stream. See also recommendation 29	Crosswind			
	4.2.4. Flow from Elogen HPP RVs	4.2.4.1. Potential full production flow via HPP RVs (may be wet or dry). Review consequences based on close out recommendation 35 (potential for high O2 concentration from HPP vent resulting in flammable mixture in H2 vent).	Hydrogen	P	5	A	5A	N		Ignition Sources	No ignition sources within H2 vent system. Static ignition sources suppressed with Earth bonding.																						
				A	4	B	4B																											
				C	4	B	4B																											
				E	3	B	3B																											
	4.2.5. Simultaneous Blowdown of all H2 storage vessels and Electrolyser (ESD 1D)	4.2.5.1. High flow through H2 vent system. No hazardous consequences, this is the design case for the H2 vent system.																																
	4.2.6. BLPH-MV-171 open more than required on N2 system	4.2.6.1. Potential for impact on other N2 users resulting in an inability to purge. Loss of safeguard.																											37. Ensure sizing of the Needle Valve BLPH-MV-171 prevents excessive N2 use which may impact other users by selecting the CV of the valve and hence maximum flowrate.	Rosetti Process			
	4.2.7. 43LIC001 control loop failure opening 43LV001	4.2.7.1. Loss of liquid level in KO drum V43001 and gas blow-by to the Brine Discharge Caisson B50014. LOPC of H2 into sea below installation.	Hydrogen	P	5	A	5A	N		43LI002	Low Low level alarm.																						
				A	4	B	4B			B50014 Caisson Location	Separation distance between Caisson discharge and main installation.																		39. Review the requirement for an additional SDV in the KO drum water drain line activated by 43LI002 low low level to prevent gas blow-by to the Caisson. To be evaluated with LOPA if required. Note that the liquid level in KO drum V43001 may be lost due to evaporation over time and if a trip is fitted this may result in a spurious trip of 43LI002 low low level alarm. Review against recommendation 40.	Rosetti Instrumentation			To be determined / re-evaluated after closeout of recommendation.
				C	4	B	4B			Ignition Sources	No ignition sources within Brine discharge system. Static ignition sources suppressed with Earth bonding.																						
				E	3	B	3B																											
		4.2.7.2. H2 into Brine Discharge header. Potential for reverse flow of H2 to other Brine Discharge locations. Review in interface HAZOP with Seawater treatment packages. Potential for LOPC of H2. [Parking Lot; What: Review in interface	Hydrogen	P	5	A	5A			43LI002	Low Low level alarm.																						
				A	4	B	4B			Ignition Sources	No ignition sources within Brine discharge system. Static ignition sources suppressed with Earth bonding.																						
				C	4	B	4B																											
				E	3	B	3B																											

Node: 4. Hydrogen Vent System

Deviation	Cause	Consequence	Hazard Register	RAM R	RAM S	RAM L	RAM RR	LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs EF Description	EFs EF Prob.	Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs CM Description	CMs CM Prob.	CMs Total CM PFD	Res. Risk. Freq.	Tolerable? Freq (/yr)	Tolerable? Y/N	Tolerable? Gap (RRF)	Recommendations	Recommendations Resp.	Recommendations PFD Improved	Res. Risk Freq. After Recs	ALARP Determination
		HAZOP with Seawater treatment packages.]																																
	4.2.8. Liquid flow over top of vent Lute	4.2.8.1. Loss of liquid from liquid seal due to high gas flow through liquid seal potential for low level in liquid seal and loss of seal. Potential for air ingress in to system leading to a flammable mixture. Not considered credible as design basis is for maximum flow through system.																																
		4.2.8.2. Gas breakthrough into lute leading to potential for flammable gas to be released onto installation.								Lute Vent	Lute vent is at safe location.																							
4.3. Flow Misdirected	4.3.1. Reverse flow of H2 to N2 system during ESD 1D	4.3.1.1. Based on loss of N2 triggering ESD 1D (64PI002) the Back pressure within H2 vent system is > N2 feed pressure. Potential reverse flow resulting in H2 being used in place of N2 in Electrolyser systems. Refer to Elogen HAZOP node 10.								BLPH-NRV-020/021	Double Non return valves, non-class 1.																				36. Review the requirement for BLPH-NRV-020/021 to be class 1 for N2 utility service considering that the life span of the installation is considered to be 2 years with no significant turnaround within that time.	Crosswind			
		4.3.1.2. H2 reverse flow into N2 package U64000. Review consequences within HAZOP of N2 package. [Parking Lot; What: N2 package HAZOP]																																
	4.3.2. BLPH-MV-417 and BLPH-MV-418 inadvertently opened (1 action)	4.3.2.1. Loss of liquid seal. Potential for air ingress in to system leading to a flammable mixture.	Hydrogen	P 5 A 5A A 4 B 4B C 4 B 4B E 3 B 3B				N		LC valve	BLPH-MV-417 is locked close valve, not valid as part of IE.																				34. Review the requirement for level transmitter and low level alarm to detect low level in H2 vent liquid seal Q43004.	Rosetti Instrumentation			PHA Team considers this scenario, after implementation of recommendations, to be ALARP and that adding additional barriers would be grossly disproportionate to the risk reduction achieved. Additional barriers considered: //
	4.3.3. BLPH-MV-419 left open after liquid seal top up	4.3.3.1. LOPC of vent gases (likely to be H2) to deck area of installation. LOPC of H2 and potential explosion within stack.	Hydrogen	P 5 A 5A A 4 B 4B C 4 B 4B E 3 B 3B				N		Maintenance Procedure Ignition Sources	Maintenance procedure to close valve after maintenance of Q43004. Area classification and hazardous area zoning to minimise ignition potential.																				43. Ensure that the seal liquid top up procedure is considered as a safety critical procedure as failure to close BLPH-MV-419 top up valve will allow LOPC of H2 on to deck area with potential for an explosion within the vent stack.	Crosswind			PHA Team considers this scenario, after implementation of recommendations, to be ALARP and that adding additional barriers would be grossly disproportionate to the risk reduction achieved. Additional barriers considered: //
4.4. Flow As Well As	4.4.1. No additional causes.																																	
4.5. Flow Reverse	4.5.1. No additional causes.																																	
4.6. Pressure Low	4.6.1. Hot relief or vent cooling down within vent system	4.6.1.1. Potential for air to be drawn in via the stack creating a flammable mixture within the H2 vent.	Hydrogen	P 5 A 5A A 4 B 4B C 4 B 4B E 3 B 3B				N		N2 Purge Liquid vent seal	Continuous N2 purge on vent system will prevent air ingress into system. Liquid seal on vent will prevent ingress into system.																								ALARP by HSSE Standards and Practices. Assessment based on: //

Node: 4. Hydrogen Vent System

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
4.7. Pressure High	4.7.1. Blockage of Flame arrestor on vent Q43004	4.7.1.1. High back pressure within vent system.								Bird Screen	Bird screen to minimise the likelihood of blockage of the flame arrestor from Guano.																							
4.8. Temperature Low	4.8.1. Low ambient temperature Consequence: 4.18.1.1	4.8.1.1. Freezing of liquid seal in Q43004 H2 vent resulting in blockage of vent relief system. LOPC of H2.	Hydrogen	P	5	A	5A	N		43PI001	High Pressure alarm on KO drum V43001																							PHA Team considers this scenario to be ALARP and that adding additional barriers would be grossly disproportionate to the risk reduction achieved. Additional barriers considered: //
				A	4	B	4B			Seal Liquid	Seal liquid is glycol water mixture with FP of minimum ambient condition.																						
				C	4	B	4B			Heat tracing	Q43004 is heat traced on seal section.																						
				E	3	B	3B																										
4.9. Temperature High	4.9.1. External Fire	4.9.1.1. Potential for failure of V43001 KO drum and release of additional H2. Escalation of incident potentially occurs as F&G system will initiate ESD 1D which will blowdown other systems through the vent system.								F&G Detection	F&G Detection system																						
4.10. Level No/Low	4.10.1. Low level in Liquid boot of V43001	4.10.1.1. Low liquid level in KO drum V43001 is expected to be normal, potentially dropping below low low level alarm point overtime due to evaporation within KO drum.																											40. Review how the liquid drain line from the KO drum V43001 can be safely routed for disposal considering that it may be subject to gas blow-by due to loss of liquid seal by evaporation. Review against recommendation 39.	Rosetti Process			
	4.10.2. Low level in H2 vent seal Q43004	4.10.2.1. Loss of liquid seal due to evaporation. Potential for air ingress in to system leading to a flammable mixture.	Hydrogen	P	5	A	5A	N																					34. Review the requirement for level transmitter and low level alarm to detect low level in H2 vent liquid seal Q43004.	Rosetti Instrumentation			PHA Team considers this scenario, after implementation of recommendations, to be ALARP and that adding additional barriers would be grossly disproportionate to the risk reduction achieved. Additional barriers considered: //
				A	4	B	4B																						41. Ensure that consideration of top up of the glycol seal in vent Q43004 is made in the design, and that there will be a 6 month period between maintenance interventions which will allow top up.	Rosetti Process			
				C	4	B	4B																										
				E	3	B	3B																										
4.11. Level High	4.11.1. Rain ingress into H2 vent stack Consequence: 4.18.1.1	4.11.1.1. Potential for high level in liquid seal Q43004 and overflow to drain resulting in dilution of glycol concentration and potential for freezing of liquid seal and blockage of relief route.	Hydrogen	P	5	A	5A			43PI001	High Pressure alarm on KO drum V43001																				42. Ensure the design of the vent Q43004 exit minimises the potential for rain ingress which may dilute the seal liquid potentially resulting in blocked outlet for the H2 vent system due to freezing.	Rosetti Process			
				A	4	B	4B			Seal Liquid	Seal liquid is glycol water mixture with FP of minimum ambient condition. See also recommendation 42.																						
				C	4	B	4B			Heat tracing	Q43004 is heat traced on seal section.																						
				E	3	B	3B																										
	4.11.2. Overfill of Q43004 glycol seal	4.11.2.1. Water with a high concentration glycol sent to wastewater tank, no hazardous consequences.																														
4.12. Phase	4.12.1. No additional causes.																																
4.13. Composition/Contamination	4.13.1. No additional causes.																																
4.14. Operations	4.14.1. No additional causes.																																
4.15. Maintenance	4.15.1. No additional causes.																																
4.16. Start up/Shutdown	4.16.1. No additional causes.																																

Node: 4. Hydrogen Vent System

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
4.17. Catalysts	4.17.1. No credible causes																																	
4.18. Utilities	4.18.1. Loss of Power	4.18.1.1. Loss of heat tracing to instrumentation and seal pot. See 4.8.1 and 4.11.1: Cause: 4.11.1 Cause: 4.8.1																																
	4.18.2. Loss of Nitrogen Supply	4.18.2.1. See No flow from N2 system 4.1.11: Cause: 4.1.11																																
	4.18.3. Loss of Instrument Air	4.18.3.1. 43LV001 moves to air fail position.																												44. Make air fail position of 43LV001 fail closed and type 6 (critical).	Rosetti Process			
4.19. Corrosion/ Erosion	4.19.1. No additional causes.																																	
4.20. Other	4.20.1. Lute provision on base of stack within Rosetti Package	4.20.1.1. Refer to Recommendation.																												30. Review the requirement for a Lute within the Elogen Package H2 vent system as the package vent discharge is via a knockout pot V43001 within the Rosetti scope. If Elogen Lute not required consider removal of the Elogen package Lute.	Crosswind			

Node: 5. Seawater and Treated Water Systems

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
5.1. Flow No/Less	5.1.1. Blocked Caisson B50013A (Marine debris or marine life)	5.1.1.1. Unable to pull seawater into system and damage to pump P50001A or Caisson.	Asset Damage to Pump(s)	A	1	C	1C			50XA001	Trip/Fault alarm on pump P50001A																							
										Spare Seawater Pump	2 x 100% capacity with automatic changeover.																							
		5.1.1.2. No flow into seawater treatment system.																																
	5.1.2. P50001A pump tripped Consequence: 5.1.3.2 Consequence: 5.1.5.1 Consequence: 5.1.6.1 Consequence: 5.1.8.1 Consequence: 5.1.9.1	5.1.2.1. No flow into coarse filter package A50003 resulting in failure of backwash cycle, operational issue requiring additional backwash cycles. No hazardous consequences. Review consequences of loss of main flow in A50003 package HAZOP								50XA001	Trip/Fault alarm on pump P50001A																							
										50PI001	Low Pressure alarm in discharge of P50001A																				45. Update the control narrative to identify alternate seawater lift pump auto-start on 50PI001/002 low pressure alarm or 50XA001/003 trip/fault alarm.	Rosetti Instrumentation			
		5.1.2.2. No flow into A50005 Ultra Filtration package. Review consequences of loss of main flow in A50005 package HAZOP.								50XA001	Trip/Fault alarm on pump P50001A																							
										50PI001	Low Pressure alarm in discharge of P50001A																							
		5.1.2.3. No flow into T50006 treated seawater tank leading to potential low level in tank resulting in loss of flow to desalination unit A50007. Review								50XA001	Trip/Fault alarm on pump P50001A/B																							
										50PI001	Low Pressure alarm in discharge of P50001A																							
										50LIC006A	Low level alarm in T50006																							

Node: 5. Seawater and Treated Water Systems

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
		consequences of loss of main flow in A50007 package HAZOP.								50LIC006B	Low level alarm in T50006																							
										50LIC002	Low Low level trip on T50006 will shutdown Desalination unit A50007																							
		5.1.2.4. No flow into A50002 Electro-Chlorination Package leading to loss of flow of Chlorinated water package. Review consequences of loss of main flow in A50002 package HAZOP.								50XA001	Trip/Fault alarm on pump P50001A																							
										50PI001	Low Pressure alarm in discharge of P50001A																							
		5.1.2.5. No flow into A50002 Electro-Chlorination Package leading to loss of flow of chlorinated water to seawater Caissons, wastewater tank and dosing of Seawater supply. Potential for bacterial growth within ultra filtration package A50005 increasing the frequency of maintenance/cleaning. Operational issue.								50XA001	Trip/Fault alarm on pump P50001A																							
										50PI001	Low Pressure alarm in discharge of P50001A																							
	5.1.3. 50XV001 fails closed	5.1.3.1. Block discharged of P50001A leading to potential damage to pump.	Asset Damage to Pump(s)	A	1	C	1C			50PI001	High Pressure alarm in discharge of P50001A																							
										50XA001	Trip/Fault alarm on pump P50001A																							
		5.1.3.2. Loss of forward flow refer to 5.1.2: Cause: 5.1.2																															
	5.1.4. 50XV004 fails closed on return line on offline Pump	5.1.4.1. Loss of chlorinated water dosing to pump leading to potential for bacterial growth and clogging of seawater system, operational issue. No hazardous consequences.																															
	5.1.5. Blockage within coarse filter package A50003	5.1.5.1. Loss of forward flow refer to 5.1.2: Cause: 5.1.2																															
		5.1.5.2. Block discharged of P500001A leading to potential damage to pump. Return flow line through offline pump may act as min flow return for online pump reducing the likelihood of damage.	Asset Damage to Pump(s)	A	1	C	1C			50PI001	High Pressure alarm in discharge of P50001A																							
										50XA001	Trip/Fault alarm on pump P50001A																							
	5.1.6. 50FIC005A/B control failure closing 50FV005A/B	5.1.6.1. Loss of forward flow refer to 5.1.2: Cause: 5.1.2																												48. Review the requirement for a flow restriction within 1"-SWR-149-01SD-E brine discharge line to caisson to ensure correct operation of 50FV005A/B.	Rosetti Process			
		5.1.6.2. Coarse filtered water sent to Brine Discharge Caisson back to sea. No hazardous consequences.																															

Node: 5. Seawater and Treated Water Systems

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
	5.1.7. Blockage within Electro-Chlorination package A50002	5.1.7.1. Loss of chlorinated water dosing leading to potential for bacterial growth and clogging of seawater system, operational issue. No hazardous consequences.																															
		5.1.7.2. Review within Electro-Chlorination package HAZOP the consequences of loss of flow through the package when package is in operation.																															
	5.1.8. Blockage within Ultra Filtration package A50005	5.1.8.1. Loss of forward flow refer to 5.1.2: Cause: 5.1.2																												48. Review the requirement for a flow restriction within 1"-SWR-149-01SD-E brine discharge line to caisson to ensure correct operation of 50FV005A/B.	Rosetti Process				
		5.1.8.2. Coarse filtered water sent to Brine Discharge Caisson back to sea. No hazardous consequences.																															
	5.1.9. 50LIC005A/B control failure closing 50LV006A/B	5.1.9.1. Loss of forward flow refer to 5.1.2: Cause: 5.1.2																												48. Review the requirement for a flow restriction within 1"-SWR-149-01SD-E brine discharge line to caisson to ensure correct operation of 50FV005A/B.	Rosetti Process				
		5.1.9.2. Coarse filtered water sent to Brine Discharge Caisson back to sea. No hazardous consequences.																															
	5.1.10. 50FIC003 control failure closing 50FV003 on chlorinated water line or manual isolation valve BLPH-MV-223/224 closed	5.1.10.1. Loss of chlorinated water dosing leading to potential for bacterial growth and clogging of seawater system, operational issue. No hazardous consequences.																															
		5.1.10.2. Review within Electro-Chlorination package HAZOP the consequences of reduced flow through the package when package is in operation.																															
	5.1.11. 50FIC002 control failure closing 50FV002 (offline pump) or manual isolation valve BLPH-MV-216/217 closed	5.1.11.1. Loss of chlorinated water dosing to offline caisson B50013B leading to potential for bacterial growth and clogging of seawater system, operational issue. No hazardous consequences.																												49. Define the control logic for chlorination of online and offline seawater caissons B50013A/B to ensure the online and offline caissons are dosed.	Rosetti Process				
		5.1.11.2. Review within Electro-Chlorination package HAZOP the consequences of reduced flow through the package when package is in operation.																															

Node: 5. Seawater and Treated Water Systems

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
	5.1.12. 55FIC001 control loop failing to open 55FV001 on Wastewater tank inlet or manual isolation valve BLPH-MV-396/397 closed	5.1.12.1. Loss of chlorinated water dosing to Wastewater Tank T55001 leading to potential for bacterial growth and clogging of seawater system. Operational issue, no hazardous consequences. Philosophy for dosing of chlorinate water into wastewater tank has yet to be determined, requirement is to analyse flow and material entering the tank and review philosophy during operation.																												49. Define the control logic for chlorination of online and offline seawater caissons B50013A/B to ensure the online and offline caissons are dosed.	Rosetti Process			
	5.1.13. Blockage within desalination unit A50007	5.1.13.1. Upstream: No flow through desalination unit leading to potential overflow of T55006 to sea. No hazardous consequences.									50LIC006A/B	High level alarm on filtered sea water tank.																						
		5.1.13.2. Downstream: No flow through desalination unit leading to potential low level in T55008. Potential running dry of P50009A/B resulting in damage to pumps.	Asset Damage to Pump(s)	A	1	C	1C			50LIC007A/B	Low level alarm on filtered sea water tank.																						
										50LI004	Low Low level trip will stop P50009A/B																						
	5.1.14. 50LIC007A control loop failing closing 50LV007A/B	5.1.14.1. Upstream: No flow through desalination unit leading to potential overflow of T55006 to sea. No hazardous consequences.								50LIC006A/B	High level alarm on filtered sea water tank.																						
		5.1.14.2. Downstream: No flow through desalination unit leading to potential low level in T55008. Potential running dry of P50009A/B resulting in damage to pumps.	Asset Damage to Pump(s)	A	1	C	1C			50LI004	Low Low level trip will stop P50009A/B																						
	5.1.15. BLPH-MV-131/134 left closed	5.1.15.1. Blocked inlet to pump P50009A/B, pump running dry at start-up leading to pump damage.	Asset Damage to Pump(s)	A	1	C	1C			50PI011/012	Low Pressure alarm in discharge of P50009A.																						
	5.1.16. BLPH-MV-130/133 Filter blocked	5.1.16.1. Electrolyser not running: Blocked inlet to pump P50009A/B leading to pump damage.	Asset Damage to Pump(s)	A	1	C	1C			50PI011/012	Low Pressure alarm in discharge of P50009A. Will not register low pressure as 50PIC013A/B will close 50PV013A/B to maintain pressure in discharge of pump.																						
		5.1.16.2. Electrolyser running: Blocked inlet to pump P50009A/B leading to pump damage.	Asset Damage to Pump(s)	A	1	C	1C			50PI011/012	Low Pressure alarm in discharge of P50009A.																						
	5.1.17. P50009A & B stop running																																
	5.1.18. BLPH-MV-136/141 left closed																																

Node: 5. Seawater and Treated Water Systems

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
	5.1.19. Blockage within S50010																																	
	5.1.20. 50PIC013A/B control loop failing closing 50PV013A/B																																	
5.2. Flow More	5.2.1. P50009A & B both operating	5.2.1.1. Potential overfill of Elogen WTP-300 and further consequences to be determined in WTP HAZOP.																												27. Ensure logic for control of P50009A/B prevents simultaneous running A & B pumps.	Rosetti Process				
		5.2.1.2. Off spec purified water to Electrolyser leading to permanent damage of Electrolyser stacks. See Elogen HAZOP 1.13.									See Elogen Package for barriers against off spec water from WTP.																							
	5.2.2. P50001A & B both operating	5.2.2.1. High flowrate into T50006 leading to potential overfill of T50006 Filtered seawater tank and sending filtered chlorinated water overboard. Operational issue, no hazardous consequences.								50LIC006A/B	High level alarm on filtered sea water tank.																							
		5.2.2.2. Review within Seawater Coarse Filter package HAZOP A50003 the consequences of high flow through the package when package is in operation.																																
		5.2.2.3. Review within Electro-Chlorination package HAZOP A50002 the consequences of high flow through the package when package is in operation.																																
		5.2.2.4. Review within Ultra Filtration package HAZOP A50005 the consequences of high flow through the package when package is in operation.																																
	5.2.3. Internal failure within A50003 Package	5.2.3.1. Review within Seawater Coarse Filter package HAZOP A50003 the potential for loss of flow restriction (failure of filter medium) resulting in high flow through the package when package is in operation.																																
	5.2.4. 50FIC005A/B control loop fails opening 50FV005A/B	5.2.4.1. High flowrate into T50006 leading to potential overfill of T50006 Filtered seawater tank and sending filtered chlorinated water overboard. Operational issue, no hazardous consequences.								50LIC006A/B	High level alarm on filtered sea water tank.																							

Node: 5. Seawater and Treated Water Systems

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
	5.2.5. Internal failure within A50005 Package	5.2.5.1. Review within Ultra Filtration package HAZOP A50005 the potential for loss of flow restriction (failure of filter medium) resulting in high flow through the package when package is in operation.																															
	5.2.6. 50LIC006A/B control loop fails opening 50LV006A/B	5.2.6.1. High flowrate into T50006 leading to potential overfill of T50006 Filtered seawater tank and sending filtered chlorinated water overboard. Operational issue, no hazardous consequences.																															
	5.2.7. Internal failure within A50002 Package	5.2.7.1. Review within Electro Chlorination package HAZOP A50005 the potential for loss of flow restriction resulting in high flow through the package when package is in operation.																															
	5.2.8. 50FIC001/002 control loop fails opening 50FV001/002	5.2.8.1. Higher flowrate of chlorinated water into online Caisson B50013A. Potential to reduce the flow of chlorinated water to offline Caisson B50013B. Operational issue, no hazardous consequences.																															
		5.2.8.2. Review within Electro Chlorination and desalination package HAZOP the consequences of high flow through the Desalination unit A50007.																															
	5.2.9. 50FIC003 control loop fails opening 50FV003	5.2.9.1. Higher flowrate of chlorinated water into T50006. Operational issue, no hazardous consequences.																															
		5.2.9.2. Review within Electro Chlorination and desalination package HAZOP the consequences of high flow through the Desalination unit A50007.																															
	5.2.10. 5.1.12. 55FIC001 control loop failure opening 55FV001 on Wastewater tank inlet	5.2.10.1. Review within Electro Chlorination Package HAZOP the potential overfill of Wastewater tank T55001.																															
5.3. Flow Misdirected	5.3.1. 50XV002 Driven open on pump discharge	5.3.1.1. Restricted orifice behind valve will minimise flow no significant consequences.																															

Node: 5. Seawater and Treated Water Systems

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
	5.3.2. 50XV003 Driven open on offline pump discharge	5.3.2.1. Reduced forward flow with water recycled to offline caisson. Operational issue, no hazardous consequences.								BLPH-NRV-008	NRV restricts reverse flow.																							
5.4. Flow As Well As	5.4.1. No additional causes.																																	
5.5. Flow Reverse	5.5.1. Reverse flow from Elogen WTP to upstream	5.5.1.1. Pressure above design pressure of 6barg not expected. No significant flow expected.								Elogen NRV CV300	Non return valve within Elogen WTP.																							
5.6. Pressure Low	5.6.1. No additional causes.																																	
5.7. Pressure High	5.7.1. P50009A & B both operating	5.7.1.1. Deadhead pressure of P50009A/B with potential high pressure on inlet side of Elogen WTP RO cells and inlet pipework leading to potential damage to RO membranes and pumps within Elogen WTP.	Asset Damage to WTP	A	2	C	2C	N																						26. Ensure the deadhead (no flow) pressure of P50009A/B is not greater than 6barg at the battery limit and that the minimum delivery pressure at operating flowrate is at least 4barg to meet the inlet requirements of the Elogen Water Treatment Package.	Rosetti Process			
	5.7.2. Blocking in of liquid lines within packages	5.7.2.1. Potential for thermal expansion of blocked in systems within packages. Review within package HAZOPs.																																
5.8. Temperature Low	5.8.1. Low ambient temperature	5.8.1.1. Potential freezing of stagnant lines resulting in rupture and LOPC of water. No hazardous consequences.								Winterisation	Winterisation of exposed lines consistent with winterisation philosophy.																							
5.9. Temperature High	5.9.1. No additional causes.																																	
5.10. Level No/Low																																		
5.11. Level High																																		
5.12. Phase	5.12.1. Gas generation within Electro-chlorination unit.	5.12.1.1. Review within Electro Chlorination package HAZOP A50005 the potential for gas generation.																																
5.13. Composition/Contamination	5.13.1. Untreated water at Elogen WTP interface	5.13.1.1. Contamination/damage of Elogen RO cells, failure of WTP and damage to assets. Any off spec water will be considered to give these consequences.	Asset Damage to WTP	A	2	C	2C																												
5.14. Operations	5.14.1. To be addressed	5.14.1.1. Operational issues review within package HAZOPs.																																
5.15. Maintenance	5.15.1. No additional causes.																																	
5.16. Start up/Shutdown	5.16.1. No additional causes.																																	

Node: 5. Seawater and Treated Water Systems

Deviation	Cause	Consequence	Hazard Register	RAM				LOPA?	>10?	Barrier Tag	Barrier Description	Validity	Protective Layer Description	PFD	SIF Summation - Threat	IE Type	IE Freq.	EFs		Total Event Freq.	Barrier Total PFD	MEF (/yr)	CMs			Res. Risk. Freq.	Tolerable?			Recommendations			Res. Risk Freq. After Recs	ALARP Determination
				R	S	L	RR											EF Description	EF Prob.				CM Description	CM Prob.	Total CM PFD		Freq (/yr)	Y/N	Gap (RRF)	Recommendation	Resp.	PFD Improved		
5.17. Catalysts	5.17.1. To be addressed	5.17.1.1. Catalyst issues review within package HAZOPs.																															
5.18. Utilities	5.18.1. Loss of Power	5.18.1.1. Loss of pumps refer to 5.1.2:																															
		5.18.1.2. Loss of Electro-Chlorination unit refer to 5.1.7:																															
		5.18.1.3. Loss of heat tracing refer to 5.8.1:																															
	5.18.2. Loss of Instrument Air	5.18.2.1. No additional consequences.																															
5.19. Corrosion/ Erosion	5.19.1. No additional causes.																																
5.20. Other	5.20.1. No additional causes.																																

Appendix D SIF SUMMATION WORKSHEET

Threat Event	Reference Number	Cause	Initiating Event		EFs		Total Threat Event Frequency	Consequence	Barriers			Mitigated Event Frequency	Conditional Modifiers (RHS Barriers)		Total Conditional Modifiers PFD	Scenario Residual Risk Frequency	Threat Residual Risk Frequency	Threat - Lowest Tolerable Frequency	SIF RRF Req.	SIF PFD Required	Recommendations			Single Line Residual Risk Frequency after Action	SIF RRF Required After Action	Threat Res. Risk Freq. after Recs
			IE Type	IE Freq.	EF Description	EF Prob.			Barrier Tag	Barrier Description	PFD		CM Descr.	CM Prob.							Recommendation	Protective Layer Description	SIF PFD			
80PI002	3.1.17.1	3.1.17. BLPH-MV-492 SB Left in closed position on Downstream line	3.1.17.1. Human Error Probability (with procedure, without checklist): HEP * number of critical steps * opportunities/ yr 3E-03*1*2. First restart after error will result in event.	6.0E-03	Unmanned platform, will be visited 1%/year, 10% assumed.	1.0E-01	2.20E-03	3.1.17.1. Upstream: Potential overpressure of pipework downstream of 25PV025A/B. LOPC of H2 and potential explosion on ignition. Not included in recommendation 21/22 for LOPA as the likelihood of this cause will not be significant.	25PIC025A/B	High Pressure alarm. Not valid as insufficient time for operator action.		6.0E-06				6.0E-06	2.2E-05	1.0E-04			20. Ensure that 80PSV001 is verified for blocked discharge downstream of 25PV025A/B during fuel cell operation. No consideration is made of advantageous control from 25PCV025A/B as per Shell rule set.			6.0E-06	-	2.2E-05
									80PI002	High High Pressure trip of PSD closing 25SDV023.	1.0E+00														
									80PSV001	Pressure Safety Valve set point at 10barg. Valid, to be sized for this case as per recommendation.	1.0E-02														
	3.1.18.1	3.1.18. Blockage in line within Fuel Cell Package, considered to be failure to reopen main isolation valve following maintenance.	3.1.18.1. Human Error Probability (with procedure, without checklist): HEP * number of critical steps * opportunities/ yr 3E-03*1*2. First restart after error will result in event.	6.0E-03	Unmanned platform, will be visited 1%/year, 10% assumed.	1.0E-01		3.1.18.1. Upstream: Potential overpressure of pipework downstream of 25PV025A/B. LOPC of H2 and potential explosion on ignition.	25PIC025A/B	High Pressure alarm. Not valid as insufficient time for operator action.		6.0E-06				6.0E-06					20. Ensure that 80PSV001 is verified for blocked discharge downstream of 25PV025A/B during fuel cell operation. No consideration is made of advantageous control from 25PCV025A/B as per Shell rule set.			6.0E-06		
									80PI002	High High Pressure trip of PSD closing 25SDV023.	1.0E+00									21. Review the required response time (PST) of 80PI002/25SDV023 to ensure that they are able to react to prevent exceedance of hydrotest pressure of the downstream pipework and Fuel Cell if 25PCV025A/B are fully opened.					
									80PSV001	Pressure Safety Valve set point at 10barg. Valid, to be sized for this case as per recommendation.	1.0E-02									22. Review the required response time (PST) of 80PSV001 to ensure that it is able to react and depressurise the system quickly enough to prevent overpressure of the pipework and Fuel Cell if 25PCV025A/B are fully opened. Consider the opening times of storage vessels outlet XVs, e.g. 25XV006 and 25PV025A/B. If PSV reaction time criteria cannot be met LOPA for 25PI002 must be reviewed.					
	3.2.5.1	3.2.5. 25PIC025A/B control failure opening 25PV025A/B	3.2.5.1. Control Loop (Electronic): Fails to danger	1.0E-01	Fuel cell in use = 135 starts/yr * 8hrs duration = 1000hrs/yr. This is roughly 10% of the time.	1.0E-01		3.2.5.1. Potential overpressure of pipework downstream of 25PV025A/B. LOPC of H2 and potential explosion on ignition.	25PIC025A/B	High Pressure alarm. Not valid as insufficient time for operator action also part of IE.		1.0E-05				1.0E-05					21. Review the required response time (PST) of 80PI002/25SDV023 to ensure that they are able to react to prevent exceedance of hydrotest pressure of the downstream pipework and Fuel Cell if 25PCV025A/B are fully opened.			1.0E-05		
					Unmanned platform, will be visited 1%/year, 10% assumed.	1.0E-01			80PI002	High High Pressure trip of PSD closing 25SDV023.	1.0E+00									22. Review the required response time (PST) of 80PSV001 to ensure that it is able to react and depressurise the system quickly enough to prevent overpressure of the pipework and Fuel Cell if 25PCV025A/B are fully opened. Consider the					
									80PSV001	Pressure Safety Valve set point at 10barg. Valid, to be sized for this case as per recommendation.	1.0E-02														
									25ZLH025[P]	Position Transmitter. Not valid as part of IE.																

Threat Event	Reference Number	Cause	Initiating Event		EFs		Total Threat Event Frequency	Consequence	Barriers			Mitigated Event Frequency	Conditional Modifiers (RHS Barriers)		Total Conditional Modifiers PFD	Scenario Residual Risk Frequency	Threat Residual Risk Frequency	Threat - Lowest Tolerable Frequency	SIF RRF Req.	SIF PFD Required	Recommendations			Single Line Residual Risk Frequency after Action	SIF RRF Required After Action	Threat Res. Risk Freq. after Recs
			IE Type	IE Freq.	EF Description	EF Prob.			Barrier Tag	Barrier Description	PFD		CM Descr.	CM Prob.							Recommendation	Protective Layer Description	SIF PFD			
									25ZLL025[P]	Position Indicator Low. Not valid as part of IE.											opening times of storage vessels outlet XVs, e.g. 25XV006 and 25PV025A/B. If PSV reaction time criteria cannot be met LOPA for 25PI002 must be reviewed.					
									25ZLH025[P]	Position Indicator High. Not valid as part of IE.																
43LI002																										

Appendix E WORKSHOP ATTENDANCE

Full Name	Company	Role	HAZOP			LOPA	
			27/11/2023	28/11/2023	29/11/2023	30/11/2023	01/12/2023
Alessandro Bucciero	Rosetti Marino	HSE discipline manager	✓	✓	✓	✓	✓
Augusto Acioly	Elogen	PM			✓		
Carolina Caracciolo	Rosetti Marino	HSE leader	✓	✓		✓	✓
Ciro Impradice	Rosetti Marino	Process leader	✓	✓	✓	✓	✓
Claudia Giunchi	Rosetti Marino	Project Engineer	✓	✓	✓	✓	✓
Davide Lo Sterzo	Rosetti Marino	Project Engineer Manager	✓	✓	✓	✓	✓
Dominik Sznajder	CrossWind	BLPH Project Manager	✓	✓	✓		
Esha Roy	CrossWind	Electrical & Integrator lead			✓		
Hamant Patel	CrossWind	PSL process	✓	✓	✓	✓	✓
Harry Parker	Risktec	Scribe	✓	✓	✓	✓	✓
Hina Arshad	Rosetti Marino	HSE Engineer	✓	✓	✓	✓	✓
Jeroen van Loon	CrossWind	Commissioning Manager	✓	✓			
Leila Shamekhi	Elogen	Project Eng. Man			✓		
Loredana Calabrese	Rosetti Marino	I&C leader	✓	✓	✓	✓	✓
Nicolas Le Brun	CrossWind	HSE Lead	✓	✓	✓		
Omkar Sane	CrossWind	Electrical & Integrator lead	✓	✓	✓		
Philip Robinson	CrossWind	I&C leader	✓	✓	✓	✓	✓
Stefan Otting	CrossWind	Technical safety leader	✓	✓	✓	✓	✓
Stephen Bremmer	CrossWind	BLPH Package Lead	✓	✓	✓	✓	✓
Steve Forster	Risktec	Facilitator	✓	✓	✓	✓	✓
Thijs Philippo	CrossWind	Renewable Energy Integration Engineer		✓	✓	✓	✓
Tirso Andres Suarez Leon	CrossWind	Operations Lead	✓	✓	✓	✓	

Appendix F LOPA RECOMMENDATIONS

For the full list of recommendations raised during the integrated HAZOP and LOPA process see the HAZOP report [Ref. 4]. A summary of the recommendations relevant to the LOPA analysis are given below for information.

	Recommendation	Responsibility	Place(s) Used
21	Review the required response time (PST) of 80PI002/25SDV023 to ensure that it is able to react to prevent exceedance of hydro test pressure of the downstream pipework and Fuel Cell if 25PCV025A/B are fully opened.	Rosetti/ Crosswind (Interface)	Consequences: 3.1.18.1, 3.2.5.1
22	Review the required response time (PST) of 80PSV001 to ensure that it is able to react and depressurise the system quickly enough to prevent overpressure of the pipework and Fuel Cell if 25PCV025A/B are fully opened. Consider the opening times of storage vessels outlet XVs, e.g. 25XV006 and 25PV025A/B. If PSV reaction time criteria cannot be met LOPA for 25PI002 must be reviewed.	Rosetti/ Crosswind (Interface)	Consequences: 1.2.4.1, 3.1.18.1, 3.2.5.1
38	Perform a dispersion calculation for release of H2 via the B50014 Caisson from a gas blow by in the V43001 KO drum. Consider the maximum pressure the KO drum may reach under all scenarios. If a hazard is created at the installation see action 39.	Rosetti Tech Safety	Consequences: 4.2.7.1
39	Review the requirement for an additional SDV in the KO drum water drain line activated by 43LI002 low low level to prevent gas blow-by to the Caisson. To be evaluated with LOPA. Note that the liquid level KO drum V43001 may be lost due to evaporation and this may result in a spurious trip of 43LI002. Review against Recommendation 40.	Rosetti Instrumentation	Consequences: 4.2.7.1
40	Review how the liquid drain line from the KO drum can be safely routed for disposal considering that it may be subject to gas blow-by due to loss of liquid seal by evaporation. Review against Recommendation 39.	Rosetti Process	Consequences: 4.10.1.1
41	Ensure that consideration of the 6 month period between maintenance interventions which will allow top up of the glycol seal in vent Q43004 is made in the design.	Rosetti Process	Consequences: 4.10.2.1
42	Ensure the design of the vent Q43004 exit minimises the potential for rain ingress which may dilute the seal liquid resulting in blocked outlet for the H2 vent system due to freezing.	Rosetti Process	Consequences: 4.11.1.1
43	Ensure that the seal liquid top up procedure is considered as a safety critical procedure as failure to close BLPH-MV-419 top up valve will allow LOPC of H2 on to deck area with potential for explosion vent stack.	Crosswind	Consequences: 4.3.3.1
44	Make air fail position of 43LV001 fail closed and type 6 (critical).	Rosetti Process	Consequences: 4.18.3.1
45	Update the control narrative to identify alternate seawater lift pump start on 50PI001/002 Low pressure alarm or 50XA001/003 trip/fault alarm.	Rosetti Instrumentation	Consequences: 5.1.2.1
46	As fuel cell runs down 25PIC025A/B opens 25PV025A/B. Ensure that when restart occurs 25PV025A/B are fully closed and review how the downstream pressure can be slowly increased to the point where 25PIC025A/B can be given automatic control.	Rosetti Instrumentation	Consequences: 1.2.4.1, 3.16.1.1
47	Review the requirement for 43LI002 High High activating ESD 1 as no scenarios were identified within the HAZOP which would activate the trip. Verify before removal that there is no requirement from project applicable standards and good practice (DEP).	Rosetti Process	Consequences: 4.1.14.1, 4.1.15.1
48	Review the requirement for a flow restriction within 1"-SWR-149-01SD-E brine discharge line to caisson to ensure correct operation of 50FV005A/B.	Rosetti Process	Consequences: 5.1.6.1, 5.1.8.1, 5.1.9.1
49	Define the control logic for chlorination of online and offline seawater caissons B50013A/B to ensure the online and offline caissons are dosed.	Rosetti Process	Consequences: 5.1.11.1, 5.1.12.1

RISKTEC OFFICES

RISKTEC SOLUTIONS B.V.
Seven Cities
Lange Kleiweg 52C
2288 GK Rijswijk
The Netherlands

PRINCIPAL OFFICE
Risktec Solutions Ltd
Wilderspool Park
Greenall's Avenue
Warrington
WA4 6HL
United Kingdom
Tel +44 (0) 1925 611 200
enquiries@risktec.tuv.com

EUROPE
Aberdeen
Bristol
Derby
Edinburgh
Glasgow
London
Rijswijk

MIDDLE EAST
Dubai
Muscat

SOUTH EAST ASIA
Kuala Lumpur
Singapore

NORTH AMERICA
Calgary
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TÜV RHEINLAND HEADQUARTERS
TÜV Rheinland Group
Industrial Services
Am Grauen Stein
51105 Cologne, Germany
tuv.com

TÜVRheinland®
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